SCIENTIFIC AMERICAN SUPPLEMENT. No. 1332

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Scientific American, established 1845.
Scientific American Supplement. Vol. LII. No. 1332.

NEW YORK, JULY 13, 1901.

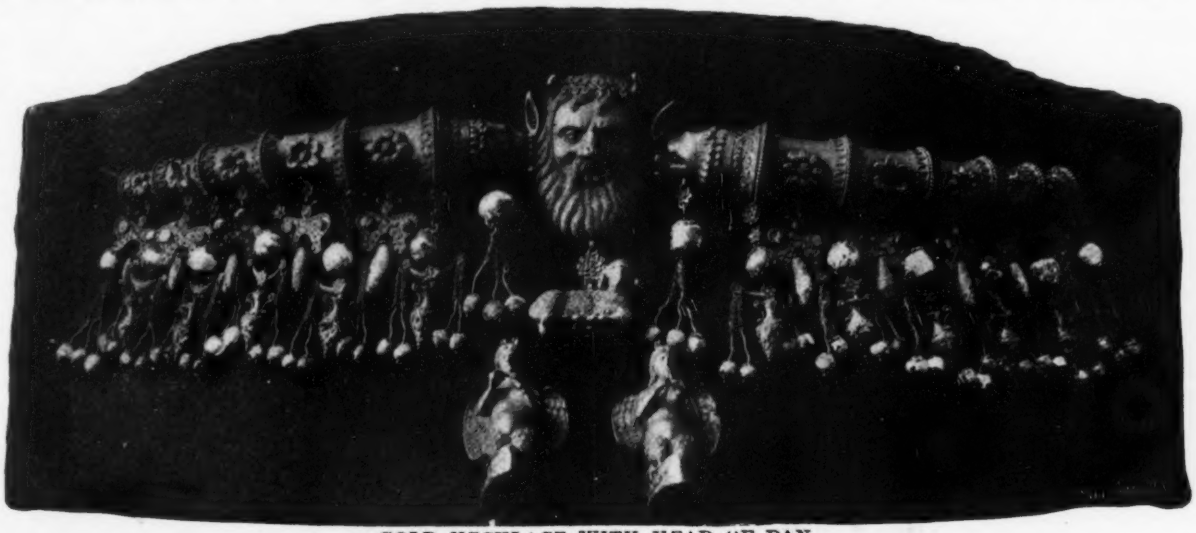
Scientific American Supplement. $5 a year.
Scientific American and Supplement, $7 a year.

GREEK GOLD ORNAMENTS FROM SCYTHIA.

THE Metropolitan Museum of Art, New York city, has, through the enterprise of Mr. J. Pierpont Morgan, recently acquired some of the finest examples of the goldsmith's art which can be traced to Greek workmanship. They include a gold crown, a votive mask, the necklace and a victor's wreath and bridal wreath. These valuable objects, which are now preserved in the gold room of the Museum, were found some little time ago at Olbia, an ancient colony of Miletian Greeks in Scythia, and are believed to date from the fourth century B. C. The gold mask, which once covered the face of a dead Grecian woman, bears an inscription which has been translated as follows: "Nikeratos, the son of Euresibos, commits his wife, Heketai, the daughter of Herosoth, to the mother of the gods at Olbia, the eighth day of the month Panemos Kindly Heketai, farewell." This epitaph shows in what esteem the departed was held. Similar masks have been found at Mycenæ by Schliemann. It was a well-known custom of the Greeks to preserve the features of the dead more perfectly than the rest of the body.

The gold crown with figures in relief is inscribed "Idytiea, priestess of Demeter" (Ceres), which proves that it was once the property and ornament of one of the priestesses of Ceres. Upon the first examination of the work on the crown, it was said that it was repoussé work. It now turns out to be just the opposite, appliqué work, which is far more rare than repoussé. The necklace was very possibly the fillet, or head ornament, of some priestess, as the head of Pan is very prominent. The pendants of glass amphoræ have been fastened to the necklace, and it is now complete. Upon its back is the word "Xexokllidis" (belonging to Zenoklides). This shows that the necklace and the crown belonged to two different persons, and not to one. The bridal wreath of gold and silver attracts great attention. It is composed of leaves of oak, myrtle and hawthorn, and is made of silver, which has become oxidized by its long exposure to the earth. Between the leaves are little buds of gold. The wreath is justly regarded as one of the most valuable pieces in Mr. Morgan's gift.

GOLD EMBOSSED MASK, FOURTH CENTURY B. C.



GOLD NECKLACE WITH HEAD OF PAN.

GOLD CROWN WITH APPLIQUE FIGURES.

Japanese Trade in the East.—English reports indicate that the influence of Japan is continually increasing in the East. The Japanese people, as well as the Government, are making energetic efforts to become economically independent of foreign aid by developing the resources of their country, creating transportation lines, establishing manufactories, etc. Japan sends almost twice the amount of goods to the United States that she imports therefrom. France receives three times the amount of merchandise from Japan that her exports to that country aggregate. From Colombo to Vladivostock, Japanese coal and Japanese matches are the most popular; and Japanese beer is the common drink. The number of foreigners doing business in Japan is steadily diminishing, and their position there is becoming more and more difficult; on the other hand, Japanese merchants are spreading abroad in an extraordinary degree. Of late, fifty-eight new Japanese business houses have been established in Pekin, and a new Japanese settlement was started in Tientsin. In Korea Japanese merchants have crowded out foreign competition. Their shipping lines are taking the place of those of European companies, and the Japanese are successful in gaining the sympathy of the Chinese.—Simon W. Hanauer, Deputy Consul-General at Frankfort.

THE RISE AND DEVELOPMENT OF EGYPTIAN ART.

By Prof. W. M. FLINDERS PETRIE, D.C.L.

WHEN a summary of what was known on early art in Egypt was read by me here eight years ago, I had to say that not a single sculpture was dated before the IVth dynasty, and that the rise and course of this art were still buried. But every year since then has yielded some portion of the early art, until now we can trace it from the very beginning.

Our first view of any civilization in Egypt starts with the beginning of cultivable land, on the first deposits of Nile soil, about 7000 B. C. Before that Egypt was only a rocky gorge frequented by wild animals and palæolithic hunters. The oldest graves that are known are of a settled pastoral people, and show that pottery and small quantities of copper were already possessed by the rude inhabitants. But this civilization rapidly developed in the fertile valley of the Nile, and the first steps of art are seen in the white clay paintings on the red pottery vases. These paintings are usually figures of goats, but some are known of hippopotami and human figures. This style of pottery painting disappeared in the early part of the prehistoric age, only being found in the first tenth of the known graves.

The carving of slate palettes in animal forms begins at its best in almost the earliest graves, and underwent continued degradation through the whole prehistoric period. The best work on slate was that of the incised outlines, such as the fine elephant which belongs to the first fifth of prehistoric times. Note how the creasing of the thick skin, the lank mass of the hind leg, and the lean forward of the beast, were all felt and expressed by the artist.

The favorite scope for animal figures was in the ivory and bone carvings on the heads of combs. These belong almost entirely to the first third of this age. They are, however, but rudely treated, and no fine or spirited work is found among them. The usual subject was a bird, but there is occasionally the figure of a quadruped. One of the latest, about half through the prehistoric, and certainly the most important, is the bust of a man, which shows the type of these people: the forehead high, beard pointed, and general type closely like the Libyo-Amorite. The same type is seen in the other figures carved in the round, in alabaster, slate, and ivory. The general low level of the figure work among these people co-existed with a very fine taste and skill in purely mechanical outline, as seen in the pottery and stone vases.

Of the later part of the prehistoric age, many examples of drawing remain on the painted pottery; and of the same style, but more varied, are the paintings on a tomb. This ship with cabins on it is much like those shown commonly on the pottery. The articles being stowed on the tops of the cabins show that they were solidly built. The propelling power is, by the vase paintings, seen to have been a long single bank of oars, as many as fifty or sixty being represented. As regards treatment, the figures of women above the ship are doubtless intended to be on the opposite side of the creek, raising their arms with the familiar Egyptian wail at the departure of relatives; this may very probably refer to the voyage of the dead, parallel to the farewell scenes on Greek tombstones. Other scenes show the wild animals and hunters; the circular trap for catching the feet of the game, with five deer standing around it; and the hunter cutting up his prey.

Another long line shows the combats of two different peoples—one black, the other red. One black man has taken three captives, and is attacked by two red men. In one single combat an adversary is killed; in another he has fallen on one knee, and has taken off his skin cloak to serve as a shield; three women in long white gowns sit by watching the fight. In all of these we see a falling off from the best work, such as that of the elephant just noticed; and this accords with the general fact that the prehistoric civilization was decadent before the incoming of the dynastic race.

There is a strong contrast between the prehistoric and the dynastic art. The former was, at its best, far inferior to the rough work of the later people; while in mechanical ability the later people show no marked improvement, and in some respects—such as flint work—they never reached the prehistoric level.

The earliest work that may be assigned to the dynastic race is the first statue of the god Min from Koptos, made rather before 5000 B. C. The figure is of the rudest, a long block with legs and arms marked by grooving; yet on the side of it, roughly hammered on the surface, is an excellent head of a stag and two *pteroceras* shells. On another statue of Min, which is more elaborated, there are several carvings, of which the hyena chasing a calf is the best, showing a good sense of expression and character.

At Koptos were also found pieces of pottery figures in the round, which explain how the Egyptians attained at once such a fine style in sculpture when they adopted working in stone. The pottery is only of coarse clay, black inside, but a fine face of hematite was burnished on the surface, which gave a high finish to the work. Only fragments were found at Koptos, such as the torso shown here; but a noble figure of a lion comes from Hierakonpolis.

From the same site comes our next half-dozen examples of the art shortly before the first dynasty. A great mass of ivory figures have shown what abundance of such work there was in this age, and how complete a mastery of carving had been attained. Besides the good proportions of the figures, we see in the carving of the heads real portraiture, as true to a type as any of later time. The characteristic form and expression of this head belongs to a fair race, and is identical with the Libyo-Amorite type, like the earlier head of prehistoric work. Hence we may accept this as the best portrait of the prehistoric race. The mixture of a negro element with the Libyan is well shown in another head carved in limestone. I was struck by seeing the exact living type in a train; and on listening, found it was an American, doubtless from the Southern States, negro-European in source. In all this work, though traces of archaic style cling to it, yet the power of expression is of the best, as showing character and race.

A rougher kind of work appears in the little glazed pottery figures of animals of the same period, which are interesting as showing the freedom of using glazes at so early a date. Glazed beads are, indeed, found very early in prehistoric times, but larger objects of glazed quartz and glazed pottery seem to come into use under the earliest kings. Glazed tiles were also made at that time for wall decorations, and continued into the third dynasty.

The fine work in hard stones seems to have come to a climax under these earliest kings, as nothing has exceeded in size and work the great syenite bowl from Hierakonpolis. The next in size (in the British Museum) is of the age of Mena, as shown by the material. The grandest point of such work may then be put to a little before the first dynasty, or about 4800 B. C.

We now come to the most important of early monuments, the carved slate palettes. And since the discovery of that of Narmer, which is now fixed by his tomb as being just before Mena, we may date all such carving to the pre-Menite kings.

The only slate with entirely animal figures was found at Hierakonpolis. It has great interest zoologically, as showing several animals now extinct in Egypt; and it has probably an historical meaning, as representing tribes by their own emblems. But here we are only concerned with it as a monument of the art of this time. The symmetric pair of leopards which frame the scenes show that such decoration was already in use, as we shall also see on other slates. Hence the Mykenæan examples were but following in a far older course. The work is of the same stamp as other examples that we have noticed, somewhat archaic, but full of vitality and character. I here notice this first as being without human figures; but it seems from its style to be later than most of the others, and probably about the age of King Narmer.

Perhaps the earliest of such work is the fragment with the bull trampling on an enemy. The wiry style of the hair and muscles is striking, and such dies out altogether in what we know to be later work. The lion in a town inclosure on the reverse has much the same character of energetic expression in the work.

The meaning of this is cleared by a piece of another slate, which shows several towns with their emblems in them; attacked by different tribes symbolized by animals, striking picks into the walls. This is clearly a record of conquest; and so far as we can get clews to the town names in later time it represents the subjugation of Middle Egypt by the allied tribes of Upper Egypt. The reverse shows rows of animals and trees, which have much the same character as the fragment with the bull, and are not far removed from the age of that. The tendency to exaggeration of the muscles, in order to give force, is what we know so well in Assyrian work, or sixteenth century Italian. It was a convention which the Egyptian rapidly grew out of, and by the second dynasty no trace of it is left. The resemblance of the treatment of the trees to those on Mykenæan work in a later age is curious.

One of the largest slates shows a long procession of warriors bearing different weapons. The style is more flat and cheap in effect, grooved lines being freely used. The scenes have not that directness and unity that we see in the other examples; and altogether, though full of interest in the subjects, it is the poorest of all in the art. The reverse of it is flat.

Pieces that belong to one of the finest slates make us greatly regret that no more of it is known. One side shows a beautiful group of two young giraffes and a palm tree. In the sense of artistic grace and design this is the finest piece of such work that is known. The other side shows a scene of subjugation; captives are being grasped by the standards of different towns or tribes, or driven forward by a conqueror clad in a long fringed robe; while the slain are being eaten by lions and vultures. The types of the captives are not like any portraits of Egyptian races, and this refers therefore to conquest outside of the lower valley of the Nile, and belongs probably to the latter part of this series of slates. The treatment of the lion's hair is that seen on ivory carvings of lions of the beginning of the first dynasty, and this again links it to the close of the pre-Menites. Possibly the king's name might be recovered if we ever find the top of the slate.

A later style seems to be presented by the only slate which we can positively place historically—that of King Narmer, who was probably two reigns before Mena. The greater amount of accurate anatomical detail without exaggeration, and the use of some hieroglyphs, point to this as the latest of the series. In this we see the conventional group of king and captive already established in the same form which lasted for 5,000 years down to the Roman dominion. The attitudes of the other figures are already on the future conventions. And the permanent system is established, although it took a century more, to the time of Zer, to crystallize the style of the art. The reverse shows that the united forces of Egypt were composed of three very different races—the long-haired, the bearded, and the usual shaven Egyptian of later time. The triumph they celebrate is over a bearded people, who wore bulls' skins and horns on the head. The taste for symmetrical pairs of animals is fully carried out in the main group below. This series of slate palettes is the finest material to show the rise of the art; and no research should be spared which could bring more to light, or complete those which we know.

The style of work on different material varies much in each reign; and the name of Narmer on an alabaster vase shows less finished work than on the slate, but of the same style.

Of the time of Mena, or just before that, are some small figures of captives incised on ivory; two of them bear vases, probably of stone, and these are subject people, who probably became incorporated with the Egyptians in later times; a figure of a captive with arms bound has a feather in the hair, like the figures of the Tahennu or Libyans in other sculptures, and is probably, therefore, of that race; another figure, clad in a long, spotted robe, like that worn by the conquerors on the giraffe slate, bows forward with a branch as an emblem of peace. In these figures we see again how varied were the people with whom the Egyptians were in contact in this early age.

Of the small work of this time there is a charming example in the ivory toilet dish of the form of a duck; the two halves are linked together by a loop at the tail, and they must have been cut out of one block. This was found containing green eye-paint in a private tomb of the age of Mena.

Several ebony tablets of Mena have been found at Abydos, and one that is perfect may serve to show the style of hieroglyphs then. It is of small size, and cut in wood, which accounts for the roughness of it; but it shows a considerable solidification of style compared with even the best work of Narmer. It gives the earliest writing that we can call a continuous inscription; all the signs before that being used singly, as labels to figures or scenes.

Of this age also is a small ivory figure, which differs in attitude and dress from all the other ivories known. And figures of a lion and dog found in Mena's tomb show that the animals were carefully studied in the round as well as on the slate carvings. The archaic heaviness of this lion should be contrasted with the more advanced work of the lions in the next reign, of King Zer. These animal figures were used as playing-pieces in a game; the bases are much worn with rubbing, and the lines of hair on the sides are worn away by the royal fingers just at the center of gravity where they were lifted. In both of these there is still archaic style, especially in the front view of the smaller lion. The treatment of the hair is exactly the same as on the later slate palettes.

The outline work attained its full growth in this reign, as seen on some of the ivory vases. The figure of a hawk is practically the same as in any later period; the style is complete, and no trace remains of the archaism of the previous reign. The fragment of a bull's head on another ivory vase shows that carving in relief was not quite so far advanced.

The main examples of decoration and technical work of this time are the bracelets of the queen, found so unexpectedly this spring upon her arm. The band of hawks in alternate turquoise and gold is a record of the culmination of the art. The history of this bracelet is that the turquoise hawks were first worn alternating with large ball beads, as shown by the wear on the edges; later on the hawks in gold were made to be threaded with them, and numbered in graded order, with straight strokes on the bases of one half, and slanting strokes on the other half of the pieces; lastly, four turquoise and five gold were lost. There are similar pieces of lapis lazuli and of ivory, also found in the tomb. Now, it will be seen that the hawks on the turquoise are of the thick style of Mena, with nearly horizontal bodies; whereas the hawks on the gold are of the completed style of Zer. The former were made early in his reign and the latter toward the close of the 57 years that were credited to him in the lists. This bracelet, therefore, just embodies the changes of that critical point in the history of the art; a change as rapid and decisive as the change in Greek art from the pre-Persian to the Phidian sculpture. The technical work shows perfect soldering and fine drilling in the terminal pieces; and the gold hawks on façades are all cast and worked over by chisel and burnishing.

The bracelet with the gold rosette has the sides, that join the front and back groups, made of a triple plait of gold wire and thick hair. The latter is probably the tail hair of oxen, and was used for threading all the bracelets. The work of soldering is perfect; the groups of three hollow gold balls are joined without showing a trace of the process, and the only evidence of solder is in the hollow gold button for the fastening, which has a shank of gold wire fastened into the inside of it with firm metallic union, proving that solder must have been used. But in no case could any trace of excess or difference of color be detected with a magnifier.

The bracelet with hour-glass beads of gold and amethyst is quite new to us in design, and no source is known for such a strange form. The threading is done by having a groove around the middle of each hour-glass, passing a thread on each side of it, and binding them together with fine gold wire.

The bracelet with spiral beads is formed of gold, turquoise, and purple lapis lazuli, which is carved in imitation of the spirals of gold wire. In the latter the wire is tapered to each end, and then coiled. The gold is very pure, as it is quite soft and unelastic, reminding us of the gold which the Indian prince purified "until it was like wax." The lazuli of this color is unknown in later work in Egypt. Other bracelets were cut out of ivory, and decorated with geometrical patterns which have a curiously modern look.

On coming to the next reign—that of King Zet, the third of the dynasty—the incised carving is seen to have been fully carried out on the stone bowls. The cutting is as flowing on this hard, metamorphic slate as on the soft ivory.

The richness of the dynasty seems to have culminated under the fifth king, Den. He was the first king who used stone in his tomb, and he grandly paved the whole of it with slabs of pink and gray granite, a labor no other king attempted to copy for centuries afterward. He first had a pictorial royal seal showing his herculean labors in wrestling with the hippopotamus and hooking the crocodile by its jaws. And the only relief inscription on a vase belongs to him—a splendidly cut panel on a large alabaster jar. He was distinctly the magnifico of that age; the work less severe and noble than that of Zer, but more showy and sumptuous.

Throughout the earlier part of the dynasty there was a standard decoration for the legs of stools or other furniture, of carving them in the conventionalized form of bulls' legs. This pattern descended from prehistoric graves, as it is found on a large scale in wood, at about four-fifths through the prehistoric age. The work of these bulls' legs is remarkable for the highly conventional decoration of the vein lines; and it might be mistaken for *cinque cento* design rather than credited to the beginning of history.

Lastly, we see here the earliest statue that is yet known, belonging to the middle of the second dynasty, or about 4350 B. C. It is obviously a long way from the archaic style, and we have yet to find a long series of sculpture to lead up to this. The head is highly finished, and more natural in the form of the eyes and mouth than any of the crowd of royal statues which filled the succeeding ages.

It is to the temple site of Abydos that we must look for the carvings on slate, and perhaps the royal statues, which will more completely fill our view of the rise of art; and it is that site to which I hope to give the next three years of work in Egypt.—Journal of the Society of Arts.

THE SEA BOTTOM—ITS PHYSICAL CONDITIONS AND ITS FAUNA.*

IT is hard to realize the fact that, up to a comparatively recent date, nearly three-fifths of the actual solid surface of the earth was absolutely a *terra incognita*, a region as unknown as the poles, and as full of mystery as the center of the earth. Yet, if it be true that the sea covers nearly three-fifths of the surface of the earth, it is also true that its bottom, which is the actual solid surface of the globe, was, up to the middle of the century just ended, absolutely unexplored, excepting a very narrow strip around the edges.

For the purpose of our study this evening, we may define the deep sea as all that is deep enough to exclude sunlight and vegetable life in appreciable quantities from the bottom. We may safely assume that this limit is at a depth of about 150 fathoms. Sensitive photographic plates are said to be unaffected beyond the depth of about 125 fathoms clear water.

It thus becomes apparent that we shall have to include as deep sea almost all the area covered by the oceans of the world, there being but an inconsiderable strip around the edges that is within the 150-fathom line. Indeed, we now know that more than one-half of the actual surface of the globe is over two miles beneath the surface of the water, and that about seven million square miles are buried under more than 3,000 fathoms of ocean.

Still greater depths are by no means uncommon. The "Challenger" sounded at a depth of 4,561 fathoms in the North Atlantic, and Uncle Samuel, not to be outdone by his British brother, very recently found a depth of 5,200 fathoms near the lately acquired island of Guam. This is, so far as we know, the deepest abyss of the ocean, being 31,200 feet, or nearly six miles. Into such a depth the highest terrestrial mountains could be plunged without any resultant peril to

* Lecture delivered before the Nebraska Chapter of the Society of the Sigma Xi, February 14, 1901, by Prof. C. C. Nutting, of the State University of Iowa, and published in Science.

navigation, as there would still be some 2,000 feet above the highest crest.

As already indicated, this vast realm of darkness was unexplored previous to about the middle of the nineteenth century. The pioneer explorer of the sea bottom was a Norwegian zoologist, Michael Sars. Then followed several expeditions under the patronage of the British Government, culminating in the "Challenger" voyage, the results of which stand to-day as a peerless example of a wise and liberal policy in the encouragement of scientific research.

The United States has come well to the front in deep-sea investigation, and now owns the best equipped vessel for this work in the world. I refer to the "Albatross," of which we shall hear more later. Americans may well take pride in remembering that the oceanic basins near our eastern and southern coasts are more thoroughly explored than any other parts of the sea bottom.

Investigations of this nature have been attended with almost insuperable difficulties, necessitating the devising of a number of entirely novel instruments and machines for this particular work. Several of the most successful of these were invented by American naval officers, of whom Captain Sigsbee, of the ill-fated "Maine," has been the most prominent. Our knowledge of the sea bottom has been gained mainly by the use of the following appliances:

1. The sounding machine.—To drop a weight attached to a line to the bottom of the sea would seem to be as simple a proposition as could well be devised. As a matter of fact, however, its successful accomplishment has taxed the inventive genius of the most accomplished engineers. Sigsbee's sounding machine, with detachable weight and piano-wire line has proved the best device for obtaining accurate soundings and adequate samples of the bottom. This and the other instruments about to be mentioned will be illustrated and briefly explained later.

2. The thermometer.—Temperature observations have been of the utmost importance in determining the physical conditions of the deep sea, and various kinds of thermometers have been devised to withstand the enormous pressure and register the maximum and minimum heat. Not infrequently these expensive instruments have been brought to the surface with their bulbs crushed to powder by the terrific pressure of the abyss.

3. The water bottle.—Not only must depth and temperature be ascertained, but the actual composition and condensation of the water must be found by means of samples that can be secured free from admixture with sea water of other depths. Here also the genius of Captain Sigsbee was equal to the emergency, and the Sigsbee water bottle has proved itself a convenient and efficient instrument, being so constructed that it will take a sample of water at any given depth and then automatically seal itself and remain hermetically closed until opened by hand.

4. The dredge.—For scraping over the bottom and securing specimens of the animal life of the deep.

5. The trawl.—A large bag-like net, useful on soft bottoms, over which it will pass without digging into the soil. It has a larger mouth and greater capacity than the dredge.

6. The tangle-bar.—To sweep over rocky bottoms on which the other instruments would foul and often be lost. It is in effect a series of long swabs that will entangle in its hempen fibers almost anything from coral rock to fishes. It is probably the most effective all-around instrument for general work, and the least likely to fall or be lost. We found it invaluable in West Indian waters of moderate depths.

With these six instruments, then, the sea bottom has been sounded, its temperature taken, samples of both water and bottom secured and specimens of its animal life brought to light, both figuratively and literally. As yet this vast territory has been but scratched here and there. We can speak with confidence, however, concerning the general physical conditions, and we are acquainted with thousands of the strange and bizarre creatures that constitute its fauna.

Regarding the physical features of this under world, the following points are worth consideration:

The temperature is uniformly low, probably below 40 degrees, except in inclosed seas in tropical regions such as the Red Sea. In many places the temperature is actually below the freezing point of fresh water. I well remember the surprise felt by the members of a dredging party one excessively hot day off Havana, indeed within sight of the now famous Morro Castle, when they plunged their hands in a mass of mud brought up in the dredge and found it so cold as to make them fairly ache. Of course the cold water reaches the surface in high altitudes, but it covers the entire floor of the ocean at depths over 150 fathoms. This practical uniformity of temperature over the entire submarine surface of the globe plays an important part in the well-known wide distribution of deep-sea species.

The general impression that high temperature is more favorable than a low one for the best development of animal life is certainly not true of marine animals in general, whatever may be the facts concerning some special groups. If other conditions are favorable, a luxuriant fauna will be developed in any temperature short of the freezing point of salt water. But a *change* of temperature, if a sudden one, is sometimes the cause of oceanic tragedies of frightful extent, a fact illustrated by the following example:

The tile-fish is a deep-water species, living upon the bottom on what is known as the Gulf Stream slope, off the New England coast. Here the water is normally comparatively warm, coming as it does from the superheated region of the Gulf of Mexico.

During a series of unusually severe gales in the summer of 1882 this mass of water was pushed aside, as it were, and replaced by the colder water. As a result, millions and millions of these fish were killed, and their dead bodies literally covered the surface of the sea for hundreds of square miles. So great was the slaughter that for years it was feared that the tile-fish were exterminated. Fortunately, however, the region has been recolonized, probably from the south, and numerous tile-fish have been taken during the past two seasons.

Probably the most remarkable of the conditions of deep-sea life is the enormous pressure, which varies of course with the depth. At the average depth (2,000 fathoms) the pressure is about two tons to the square inch of surface, and at 4,000 fathoms each square inch of surface is subject to a pressure of about four tons. This fact led the earlier physicists to maintain that organic life was impossible in the great depths. It has been proved, however, that animals of all classes, except the higher vertebrates, have been dredged from even the deepest abysses of the ocean.

The great pressure to which they have been subjected has a curious effect on the deep-sea fishes when they are brought to the surface. Under these circumstances, being released from the accustomed pressure, they fall to pieces, as it were. The eyes bulge out, the swim-bladder protrudes from the mouth, the scales fall off and the flesh comes off in patches, the tissues being remarkably loose. Now these fishes, disreputable as they appear when brought to the surface, were doubtless respectable enough in their proper habitat, and, like some other creatures, become loose and far from correct in appearance when away from home, simply because the pressure is less.

In the depths they are doubtless no more conscious of the pressure of four or five tons to the inch than we are of the fifteen pounds of atmospheric pressure under which we live and move and have our being.

Owing to the incompressible nature of water it does not differ appreciably in density at different depths, and any object that will sink at the surface will continue to sink until the bottom is reached, however deep that may be.

The presence of oxygen is of course of vital import to animal life in the deep sea as elsewhere, and it was long deemed impossible that any considerable quantity of oxygen could exist at great depths. It has been found, however, that there is no lack of this vital element either near the surface or in the deepest soundings. Sir Wyville Thomson, the naturalist in charge of the "Challenger," made a very careful study of oceanic currents and found that the cold water of the polar regions, charged with oxygen derived from the superincumbent atmosphere, creeps along the bottom toward the equator from both poles, thus carrying oxygenated water over the vast area of sea bottom throughout the oceanic floor of the world. It also appears that the general trend of the surface water is toward the poles. This great scheme of circulation involves the general rise of the cold, deep water of the equatorial regions toward the surface, where it receives a fresh supply of heat and oxygen, carries much of the heat to northern regions and, after giving it off, returns southward again in the form of oxygen-bearing undercurrents. To my mind there are few terrestrial phenomena more impressive than this majestic cosmic current with circulation slow and sure, carrying with it the tremendous potency of life to and throughout the uttermost depths of the sea. Were it not for this world-circulation, it is altogether probable that the ocean would in time become too foul to sustain animal life, at least in its higher manifestations, and the sea, the mother of life, would itself be dead.

The condition of the physical environment of the life of the ocean depths that strikes one as the most forbidding is the practical absence of sunlight from the enormous area included in the deep sea. As already stated, actual experiment has shown that photographic plates are not affected at a depth of over 125 fathoms in clear water, and light, which cannot be detected by the exceedingly delicate eye of the camera, is surely invisible to any organ of vision constructed on the same general plan as the human eye. There is practical agreement among all the authorities, save one, that I have been able to consult that the rays of the sun do not penetrate perceptibly below the 200-fathom line at the farthest. Professor Verrill is the exception referred to, and he has advanced the theory that a pale green light penetrates even to the deepest waters. He thinks that all the other colors of the spectrum are removed from the sun's rays by absorption, leaving the green rays only. He comes to this conclusion from a study of the colors of the animals of the deep sea, which demonstrate, in his opinion, the presence of light of some kind. He apparently assumes that this light comes from the sun, and resorts to the explanation just referred to to prove its presence in the oceanic depths.

We shall see presently, I hope, that it is not necessary to assume the presence of sunlight at the sea bottom in order to meet the demands for light revealed by a study of the coloration of its inhabitants.

The bottom waters, then, are almost freezing cold, subject to tremendous pressure, moved by slow currents creeping from pole to equator, supplied with sufficient oxygen to sustain animal life, and devoid of sunlight. Could a more uncomfortable and altogether forbidding habitat be conceived of for an animal population? Certainly not, from our standpoint. But it must be remembered that we are neither fishes, nor mollusks, nor jelly-fishes; and that everything depends upon being used to environment. A practical application of this fact would result in the saving of a lot of otherwise wasted sympathy in human as well as zoological affairs.

Let us now turn our attention briefly to the topography of the sea bottom. It may be said, in general, that there are few abrupt changes of level; that the ascents and descents are gradual, and that there are few areas which, if laid bare, would present anything like the broken contours of a mountainous region. In areas adjacent to continents and archipelagoes the topography is often considerably broken, but away from the land masses the sea bottom is, ordinarily, as level as a western prairie. Few, if any, bare rocks are to be found, except where recent submarine volcanic explosions have torn up the subjacent strata, or the cooling lava has encrusted the bottom. Practically the entire sea bottom is covered to an unknown depth by a soil that varies with the depth in a definitely determinate manner. This soil, like that of the upper world, is organic in its origin, being composed in large proportion of the remains of a few species of very widespread forms, individually minute, but collectively of stupendous bulk. These animals belong almost exclusively to the Protozoa, or one-celled forms, and largely to the class Rhizopoda. They are of immeasurable importance from a biological standpoint, furnishing, as they do, the food basis for all marine life. As a type of these organisms *Globigerina bulloides* stands forth pre-eminent, a form of exquisite beauty of structure, being like a series of minute chalky spheres, exquisitely sculptured, from which radiate many and almost infinitely slender and delicate spicules which serve to support the living animal on the water, which, in places, is rendered of a reddish color by the hosts of these Rhizopods. It has fallen to the lot of but few naturalists to examine these creatures in a living and perfect state, as the slightest touch will rob them of their beautiful spicules and cause the living protoplasm to retreat within the hollows of the spheres. Minute and fragile as they are, the skeletons of these animals and of others equally small, cover at the present time many millions of miles of the sea bottom, and in times past were the main element in building up the mighty chalk deposits of the world.

If we were to run a line of soundings from the continent of North America eastward to the mid-Atlantic, we should find that the bottom could be easily divided into three regions on the basis of the soil, as I have termed it, covering everywhere the actual rocks. For the first few miles the bottom would be covered with débris of many kinds from the adjacent land. Rocks and gravel and sand, together with mud and silt, if near the mouth of a river, would succeed each other. The surface might be broken into rocky pinnacles and caverns, water-worn in fantastic shapes in the region of a rocky coast; or, if the coast be low and sandy, there might be a perfectly even and gradual slope from the shore to a depth of 150 or perhaps 200 fathoms.

This slope, covered with continental débris, is known as the "continental slope," and is very apt to be more uneven and broken in its topography and to support a more luxuriant fauna than any other part of the sea bottom. Beyond the continental slope the descent becomes more abrupt, leading down to a depth of 1,500 fathoms or more.

The bottom samples will now take on a distinctly different character, being composed of a grayish mud. If a little of this is examined under a microscope, it will be found to be made up of countless millions of the tests of *Globigerina* and other unicellular animals. Not a single thimbleful of this mud is devoid of its hosts of skeletons. This wet and slimy bottom soil is known the world over as *Globigerina ooze*, and it covers the ocean floor for many millions of square miles.

In a line of dredgings made by the "Challenger" from Teneriffe to Sombrero, taking in the widest part of the Atlantic, about 710 miles were found to be covered with *Globigerina ooze*, which was found in characteristic form from a depth of 1,525 to one of 2,220 fathoms. Beyond the latter depth the bottom was of a distinctly different character, changing to an extremely fine-grained reddish-brown mud, oily to the feel. It is so finely divided that it takes many hours to settle when mixed in a glass of water. This is known among oceanographers as red clay, and is supposed to be derived almost exclusively from two widely different sources:

First.—The residue of the innumerable hosts of pelagic animals remaining after their calcareous skeletons have been dissolved in sea water.

Second.—Pumice and volcanic dust, either from submarine upheavals or from the atmosphere. From either or both of these sources the accumulation of the red clay must have been almost infinitely slow, taking perhaps millions of years to deposit a few inches in thickness on the ocean floor. This sort of bottom deposit is of much greater extent than either of the others, and is supposed to cover about one-half of the sea bottom, an area greater than the total land surface of the globe.

It can easily be conceived that no stretch of the land surface can compare in dreary monotony with those awful solitudes of the *Globigerina ooze* and the red clay. Even if illuminated by the sun's rays, they would be forbidding and dreary beyond compare.

Resting immediately upon the bottom already described is a layer of unknown depth of a flocculent material that is of incalculable importance in our discussion. When first discovered this substance, owing to its strange movements in alcohol, was supposed to be alive, and was described by Huxley under the name of *Bathybius*, and considered as a sort of primordial organism from which the entire life of the globe may have originated. *Bathybius*, however, was doomed to be regarded as one of the colossal jokes of science, and a thorn in the flesh of its describers.

But, after all, it is now thought that the much-derided *Bathybius* is fully as important as claimed by Huxley, but in another way. It is not alive, to be sure, but still it is organic, consisting of the partially decomposed remains of the pelagic animals, such as *Globigerina* and other forms already referred to. These have died near the surface, and have gradually but surely found their way to the bottom, where they remain partially suspended in a layer of soup-like consistency and character. *Bathybius*, then is now no longer known as *Bathybius*, but as "bottom broth," an exceedingly suggestive term, and it is supposed to be the inexhaustible supply of nourishment, the basal food storehouse of the innumerable creatures that live and move, or simply live without movement, at or near the bottom of the sea, the simplest and most helpless of which have but to open their mouths, if mouths they have, and suck in bottom broth as the infant does pap. If Old Ocean is really, as so often asserted, the mother of terrestrial life, then bottom broth can truly be regarded as a sort of mother's milk, for the nourishing of her weak and helpless offspring.

(To be continued.)

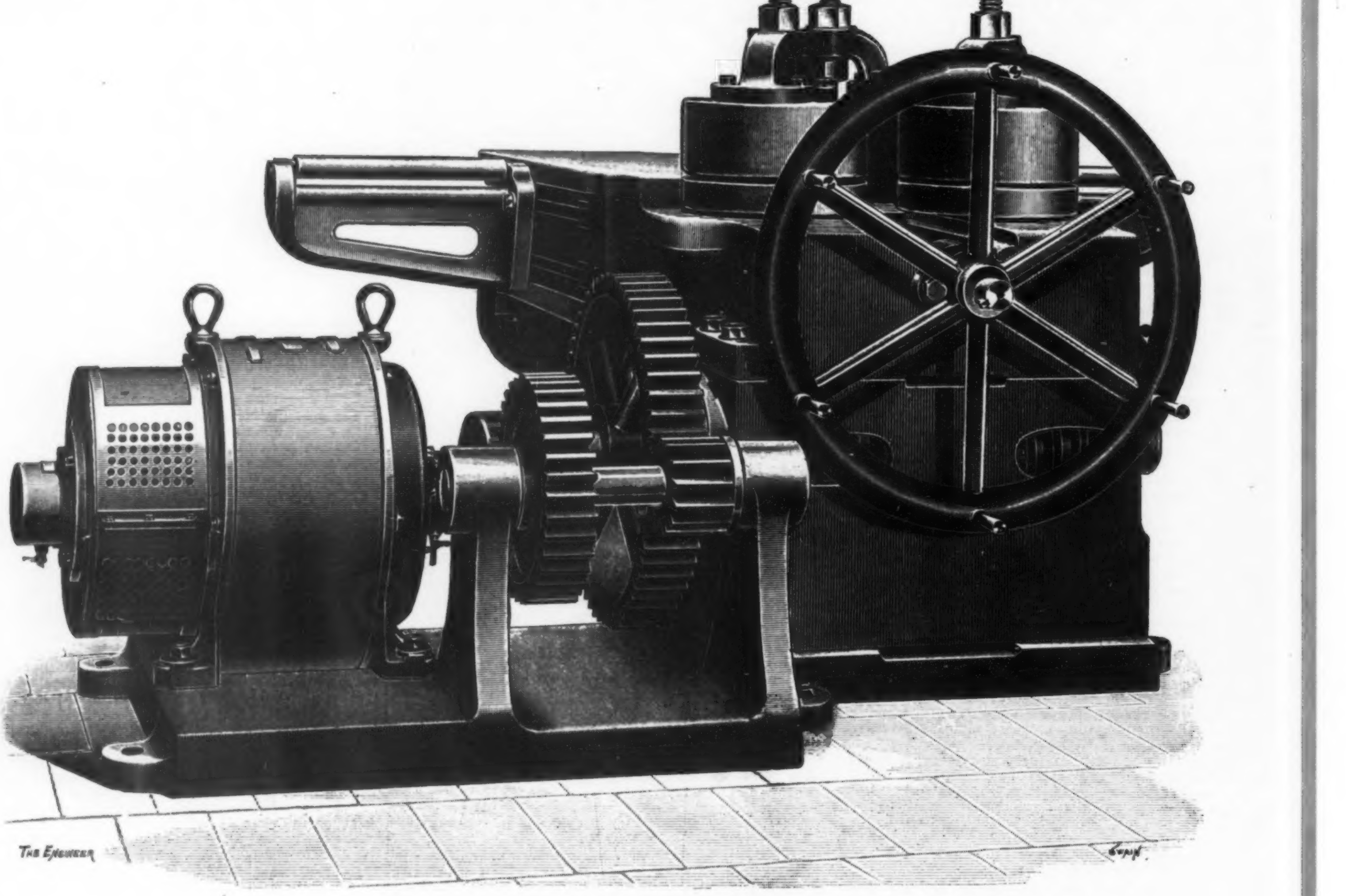
According to a consular report, asbestos covered rubber tubing is being used in Berlin. The rubber is coated with asbestos and the asbestos with metallic paint. By this arrangement the tubing is protected against damage by contact with hot apparatus.

MACHINE TOOLS FOR PLATES AND ANGLES.

No neater application of electricity to the driving of machine tools is to be found than in the case of punching, shearing, and bending machines. The fact that the power required is as a rule large enough to warrant the use of an independent motor for each machine, and the absence of speed change gear, renders the designs as a rule simple and effective. The angle and T-iron bending machine illustrated is a case in point.

It is a powerful tool, which will bend angle iron up to 6 x 6 inches and T-iron flat bars or manhole rings can be bent by arranging the rollers to suit. The machine is made very strong, so as to stand the hammering down of the angle iron while being bent. The top of the table is planed perfectly true for the work to rest on. As will be seen by the illustration, the rollers are in two parts. The bottom part projects, say, 1-16 inch above the top of the table, so as to relieve the friction with the table. The top part of the rollers can be readily adjusted for different thicknesses of angle iron to be bent, by the bridges and nuts on the top of the spindles, which are chased for this purpose. This arrangement saves a considerable amount of time compared with the lifting off of the rollers and putting in washers to pack the top rollers up for various thicknesses of angle iron. The machine is driven by powerful spur and worm gearing. The three brackets shown on each side and end of the machine are to support the iron when bending large diameters, and can be readily removed. This machine has been made by Rushworth & Company, of Sowerby Bridge, for a large shipbuilding firm in America.

We illustrate also a belt-driven horizontal beam-bending, straightening, punching, riveting, and double-angle iron-cutting machine, by the same firm. The machine has also special arrangement at one end for punching channel iron, and also T-iron near the edge. At this end of the machine a steel forging is fitted into a recess, planed out and arranged to carry the punching die in such a manner as to get near the root of the angle or T-iron; also in order that, say, 4 inch section channel iron can be punched. This machine will punch 1-inch holes in 1-inch plates 10 inches from the edge. It is fitted with improved stop motion to the slide. When this end of the machine is required for riveting the steel forging is taken off, and adjustable riveting dies fixed in its place. The other end of the machine is arranged to bend beams up to 14 inches deep. The beams to be bent or straightened are carried on the two rollers shown in the illustration, which can be raised or lowered by hand wheels and screws to suit the various sections of beams to be dealt with. The two rams shown are of forged steel, and are adjustable endways and sideways from about 16-inch to 26 inch centers, so as to bend any curve required. This slide is also fitted with stop motion. The machine is arranged in front to cut angle iron 6 inches by 6 inches by ¾ inch, either right or left hand, and of any length. It can also be arranged to cut angle irons in one place and flat bars in the other. This slide also is fitted with stop motion. The machine has a steel eccentric shaft, strong, double-power gearing, with fast and loose pulleys, and heavy fly-wheel. The weight is about 8¾ tons.—For our engravings we are indebted to The Engineer.



ANGLE AND TEE-IRON BENDING MACHINE.

THE MAKING OF A GREAT ATLAS.

By SPENCER TOWNSEND.

THE comprehensive atlas of to-day, fitted for both home and commercial uses, has grown to be much that is beyond the mere collection of suitably colored map pages which our forefathers knew as an atlas. In these days of many and diversified interests, it has become necessary to incorporate within the covers of an atlas not only the maps which illustrate the world and its subdivisions, of countries, states, and cities, but as well, very painstaking descriptions of the countries so mapped, comprehensive and down-to-date statistics of those countries whether of population, commerce, manufactures, or other departments of their life and enterprise, and in addition thereto it is now considered requisite to add historical matter of wide reach and encyclopedic accuracy, together with such mapping and charting of the heavens as will make plain that "larger geography" in which our world is only a minor part. Still further, there must be complete and accurate lists of all the principal cities and most of the towns, of any size whatever, mentioned on the scores of maps which go to make up the cartographic feature of the atlas; and these must be arranged alphabetically; must as far as possible give the statistics of each place in question, and a key-sign must also be given whereby the location can be accurately placed upon the indicated map. Here, then, we have a great field of endeavor which calls, not for the work of one supervising editor alone, but for that of a considerable number of compilers and revisers, whose watchword must invariably and always be "Accuracy." And all this work must go on under the direction of a publisher to whom expense is a minor consideration, when this watchword is at stake.

Taking up first what will seem to most users of an atlas its most important feature, its maps, it will be of interest to trace the method by which a new and accurate map, with all its featural details brought down to date, must be produced. In the first place, to prepare for such a work the editor of this department gathers about him from every possible source the very best and latest maps and charts of the political division which is to be shown on the desired map. If it is a State map of the United States, for example, several departments and bureaus of departments of the Government at Washington must be consulted, in order to obtain from them the best and latest of their productions. To the Post Office Department the editor turns for the latest information regarding the location of post offices; to the Coast and Geodetic Survey, for the coastal outline of the region to be mapped, if it has such, and for the accurate representation of the courses of navigable waters; to the Geological Survey for representations of such physical features as the contours of mountain and valley, the courses of minor streams, the position and outline of lakes, etc.; to the Land Office especially for lands, still in the possession or under the control of the United States, parks and timber reservations, and for features not shown by other departments; to the War Department for the army maps, for the excellence of which they are famed; to the Navy Department for charts and surveys not issued by other departments, showing special naval features; and to the Indian Commissioners for the locations of reservations and Indian agencies, if such there be within the territory to be represented.

This country, possessing as it does more than one-half of the railroad mileage of the world, especially demands that keen attention should be given to all railway features upon the maps of any one of its States. Building roads at an average of about 4,000 miles of new construction per year, and thus constantly opening up new territory where frequently towns and villages blossom over night and every monthly report shows the presence of new post offices, it becomes necessary to keep also in touch with railroad maps, and railroad builders and their intentions, so that, in addition to all the features shown on the Government surveys, the map may be thoroughly up-to-date in this great department of travel.

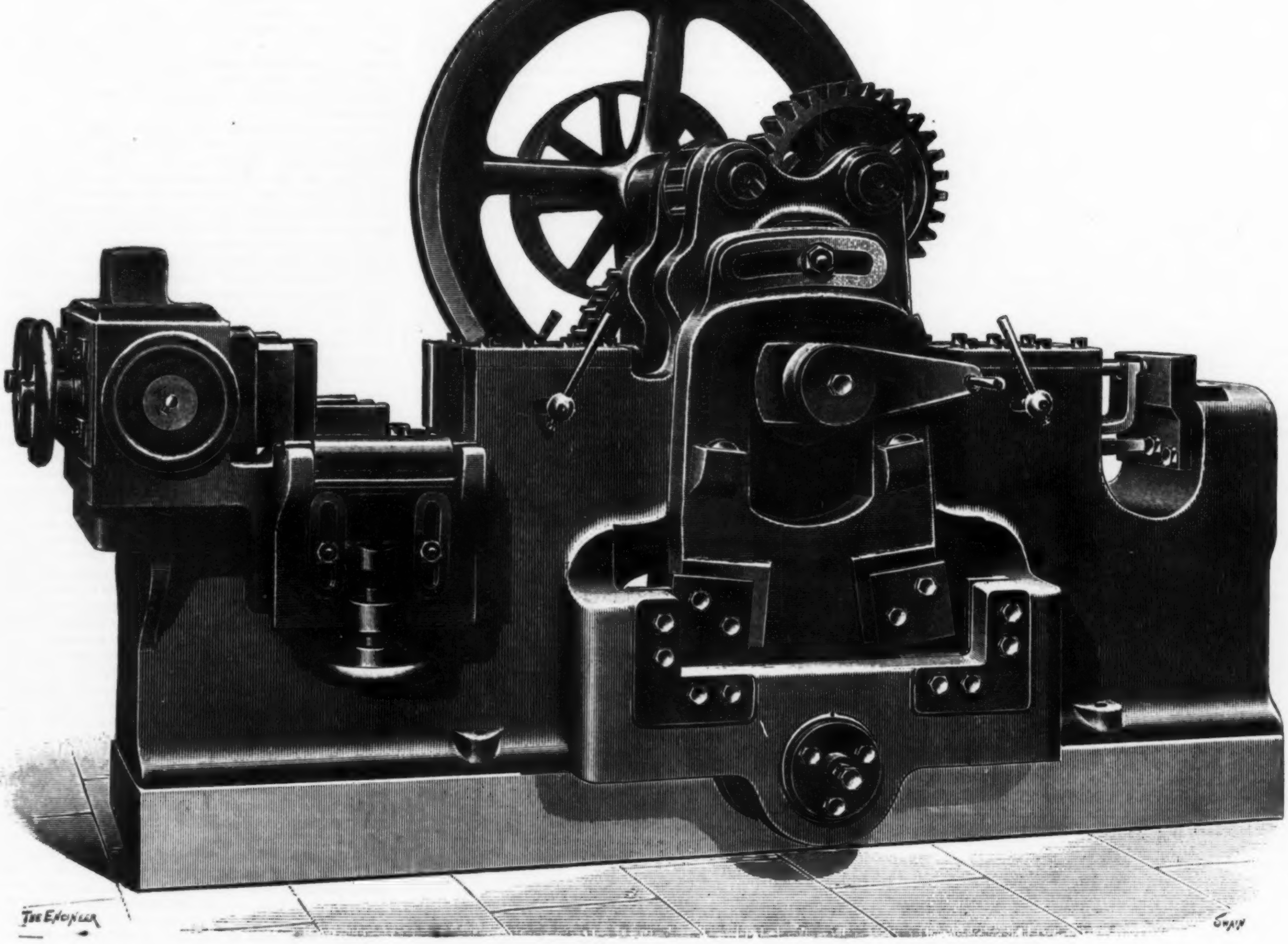
Having assembled all of these authoritative maps and charts before him, it becomes the work of the editor to harmonize them, to discover every point wherein they differ, ascertain from undoubted authorities which of them are correct and which not so, and thus, by combining the best features of each, produce as far as may be possible in this ever-changing world, a map that is thoroughly accurate at the time of its appearance. This to the reader may sound like a not very difficult undertaking, and in the more settled portions of this country it is perhaps nothing more than a task requiring infinite pains and a conscientious grasp of details. But in newer territory, where at first names are diversely spelled and frequently of very obscure origin, where even the greater features of the map are all too frequently carelessly surveyed, and where every month marks new developments that require here a correction, there an erasure, and beyond an addition, the work requires a degree of editorial capacity of no mean sort.

When, however, we leave our own country and depart from the more civilized portions of other lands, taking up the maps of such areas as those of China, India, or interior Africa, for example, where every traveler returns with a new system of spelling, and the maps of no two nationalities agree in this regard, the work passes beyond that of the mere cartographer and patient compiler of easily ascertained data, and bristles with questions only to be decided by the linguist or by continual reference to such published authorities as may be regarded as being courts of last resort. Working on the map of China, for example, with various books at his right hand, selected because of their authors' standing in matters of this sort, the editor must choose between Niuchwang, Newchwang,

Niew-chwang, or Niutschuan, and having decided upon one of these, after finding that our own National Board on Geographic Names, the Royal Geographical Society, and the French Geographical Society each choose a different spelling, he is still face to face with the fact that this interesting and unpronounceable town is a treaty port of the Province of Liaotung, Leao-tong, or Leu-tong, as he may select. The editor need not go so far afield, however, to find quite sufficient troubles of this sort. Coming back toward home as far as Russia, he will reach the town of Nizhni Novgorod, and if he does not like this spelling, he has the choice in the first part of the name of Nijni, Nijnii, Nijniy, Nischnii, or Nizhnee, all used by more or less excellent authorities; and if there is not sufficient confusion for him, he may find authority for changing the spelling of the last name of this Muscovite boro in two or three other ways. Coming still a little nearer home and reaching the principal city of Saxony, Germany, he will find the German authorities, the Royal Geographical Society, and our own official Board instructing him to spell the name of that town Leipzig, and not Leipsic, although the Standard Dictionary, which seems to have a fondness for going wrong on place names, will give him the latter spelling, but in Danzig, not so very far away, will retain the final zig, in one of those fine displays of illogicality for which dictionaries are particularly famous. Having reached this near home, it is perhaps just as well to return to look at our own foibles and weak points, and to discover that the long famous Mississippi Light is not Muscavédder, as we so long thought, but Muscovalley, that both Osborn, Illinois, and Osborn, Kansas, must drop their final e, while that of Minnesota must have it added, and that of Maryland must hereafter be called Townshend; and so it will go column after column and page after page, correction piling upon correction, and the distressed and worried editor feels like breaking away to the inner wilderness of his favorite lake in Maine, until he discovers that it is not quite certain whether his favorite lake is to be spelled Pemadumcook, Pamedemcook, Pamadumcook, Pamedomcook, or Pemedumcook.

To leave our editor deeply enthralled in the mysteries of his particularly difficult work and return to the mechanical and more interesting side of the art of map making, we may describe the process that follows after the corrected first draft is completed and the engraver is ready to begin his plate, about as follows: first there is chosen a finely polished plate of copper of the desired size, which the engraver covers with a compound known and secret to his art. Taking the drawing which has been perfected under the editor's supervision, he lays it down upon the compound-covered face of the plate and with a sharp tool carefully traces it so that its outlines of different kind are transferred through this impressible substance. If the drawing prepared by the edi[illegible] not of the exact size, a photograph is made of it, and a print of this photograph is used as the basis of this transfer process, which, having been finished, is the outline, or, let us say, the hair-line basis of the map to be made. Now come into play many diverse and delicate engraver's tools, of various widths, with which to cut, through this plastic coating, coast and other boundaries, rivers, railroads, mountain contours, etc. Much depends upon the skill with which this compound is placed upon the copper surface and upon its thickness, which will vary from one-sixteenth down to one-hundredth part of an inch, according to the sort of engraving that is to be made. After the transference of all these details to the plate, the various place names, river names, mountain names, etc., all of the lettering in fact, are set up in different and appropriate types, according to the original drawing passed upon by the editor, and the plate then goes to the hands of the stampers. The stamper has a table, in the center of which is a stone from two to three inches thick, under which a gas light burns to keep it at an even temperature. On this stone the plate is placed, and upon this surface the inverted types are carefully stamped in their proper positions. Every name having been placed upon the map as indicated in the original drawing, the plate and this drawing now go to the proof reader, who carefully compares one with the other, the lettering of the original or editorial copy with the cutting on the copper plate, painstakingly going over the spelling of each word, observing that it is properly placed and in proper type; and any mistakes, if such are discovered, are marked to be obliterated and restamped by the engraver and stamper who did the work. Now the plate goes to a special artisan who "builds up" the thin layers of the compound, so that it will be of the right thickness for an electrotype; and then the plate is carefully gone over and "picked up," as it is called, that is, in such places as the "builder" may have melted over a river line, or town or mountain name, the building having been done by a heated iron and some more of the compound already used on the plate, these must be restored as at first. This picking up, or correcting obliterations in the compound having been completed, the plate is now covered with a solution and sent to the electrotyper's, where it remains in a bath for at least twenty-four hours, after which it is covered with a layer of lead of perhaps three-sixteenths or more of an inch in thickness, and the top or printing part is discovered to be a thin shell of hard copper, scarcely of a hair's thickness, backed by this layer of lead. This metal plate now goes to the finisher, who touches up such minor imperfections as may have occurred in the electrotyping process; here a slightly roughened surface to be smoothed, or there a minute protuberance to be shaved down, and then it is mounted on one of the ordinary cherry wood blocks, such as are used under all electrotypes or metal illustration surfaces and which bring the printing surface up to the proper height for use on the bed of a press. Proofs of this map are then taken and one of these proofs is transferred to each of as many copper plates as there are to be different primary colors used on this particular map, the color or tint lines on these being made by a ruling machine, and each block in turn being built up and electrotyped as already described in the first block, which is to be printed in black ink. Now, if editor, engraver, stamper, builder up, and proof reader have all done their work as they should we have a finished map plate or set of plates, which will print a map brought down to the period when it was started, perhaps two or three months before it was entirely finished. At last it is ready for the pressman, when map printing becomes the part of atlas publication which he is engaged upon. As soon as the first completed proof is taken, however, it is sent to the editorial department for the purpose of indexing, or, making from its place names, a complete gazetteer. On such a map along two parallel sides will be a certain number of letters of the alphabet, and on the two other sides the requisite number of numerals. These enable both the editor and the purchaser of the completed atlas to find any given area on the map, because it is by their aid divided up into squares, such as A-3, C-5, G-8, etc. With these as a guide, editorial assistants carefully copy all of the names in a square, taking each square in order, until the map is entirely gone over, and then these names are arranged alphabetically, or perhaps incorporated alphabetically with other names from other maps, if more than one map is devoted to this political subdivision. This list goes to the compositor, is set up, when in the type is repeatedly read with care from the manuscript list, by proof readers, and then returned to the editorial department to be compared with the map, there finally passed upon, and at last made up into permanent pages. It is doubtless well understood that each colored map must be run through the press as many times as colors appear on it. In other words, the black outlines and place names having first been printed, the red, blue, and yellow follow, one impression at a time, the paper passing under entirely different forms and due time being given to allow the ink to dry after each impression. The primary colors are usually the limit of the number of impressions, green being frequently a combination of yellow lines running in one direction and blue lines crossing them, and orange the same sort of combination between yellow and red. The care that must be taken in what pressmen know as "the register," whereby the various colored blocks meet and match exactly and correspond with the black under them, often calls for the most extreme patience; yet, even with the utmost care, such is the tendency to give on the part of the paper that sometimes inaccurate impressions are produced, and these must eventually be discarded. The atlas sheets so far as maps are concerned are now ready for the binder, some of them containing four and some as many as sixteen pages on one sheet of paper.

Naturally, the binding of such a book as a large atlas, while it is a question of the ordinary machine sewing, cover stamping, marbling of edges, etc., must be done with unusual care and firmness to sustain the great weight and strain in such a book and at the same time enable it to open in such a way that every



COMBINED BENDING, PUNCHING, RIVETING, AND SHEARING MACHINE.

part of it is accessible to the student. Having attended to all of these details and the finished book having come from the binding presses and been suitably wrapped for shipment, it is then ready for delivery throughout the country wherever a large and efficient army of agents have found buyers for it. It may appropriately be said here that the really valuable high class atlas is not to be purchased in book stores, is not to be had as newspaper or magazine premiums, is not to be obtained at cut rates, and thrown in with some encyclopedia or other work of reference, but is sold on its own unaided merits by skillful canvassers to those who have had an opportunity of thoroughly examining it before purchase. It must appeal to all that the atlas which can be thrown in as a premium for a three or four dollar newspaper or magazine, or sold at half rates on the instalment plan, is published from old plates and is not in any sense of the word a modern, up-to-date production.

So much for the making of maps, the printing and binding of the atlas, and getting it on the market. Before this point has been reached, however, there must have been written under the same editorial management, but by a different staff of assistants, those political, historical, and statistical descriptions and tables, the compilation and verification of which calls for an amount of labor that very few, none in fact who have not attempted such work, can thoroughly appreciate. Let us take, for example, the pages of the descriptive matter having to do with the history, physical features, government, judicial and educational affairs, climate, products and industries, and the principal cities of our State of New York. It is a fact, but little appreciated by most readers, that works of historical reference are quite as apt to radically differ in their statements of important and ascertainable dates, as they are to agree. And even in the spellings of place names, or of the names of persons in early history, these differences are frequently very marked. We have already seen how recently published and much vaunted dictionaries may be at sea in the spelling of foreign place names, and we are, therefore, prepared to find that in the name of the early discoverer of New York Bay, Giovanni da Verrazzano, as an example, such authorities as the Century Dictionary of Proper Names, Haydn's Dictionary of Dates, Lippincott's Gazetteer, and other like works of major authority do not agree and not one is correct. Therefore, the verification of the exact spellings of all doubtful proper names becomes a matter calling for the utmost editorial skill and care. Again, we find historical works of the foremost rank differing materially as to the important dates in earlier history, and not alone in earlier history, but in later as well. For example, five prominent reference works of an encyclopedic nature give four different dates as the day upon which the State of Wyoming was admitted to the American Union, and yet here is a recent date that is easily ascertainable from the government records. So it is all along the line, verification of every statement must be made with the utmost care. The latest educational data must be obtained from the reports of the U. S. Commissioner of Education and from State reports upon the same subject. Every stated altitude must be verified in the government's "Dictionary of Altitudes." The spellings of rivers and their tributaries, mountains, lakes, and every place name must be carefully verified in the reports of the United States Board on Geographic Names. The commercial and industrial life of the State under consideration must be ascertained from a number of sources, such as the statistical works of the Treasury Department, the various reports of the Agricultural Department, the Commissioner of Labor, and so on through a considerable list of both National and State governments. Local guides must be consulted and their statements verified in search for the latest facts regarding the principal cities and the relative importance of these be proved by the lately issued bulletins of the Twelfth United States Census. One after another, perhaps beyond the half dozen limit, books must be consulted in verification of each one of these apparently minor details and in not a few cases where these "doctors disagree," letters of inquiry must be written to local authorities who will have an absolute knowledge of the matters inquired of, because of their being on the spot.

To the reader many of these items of information, these dates, place names, and names of men prominent in history may seem of minor importance, and certainly they will imagine them to be of easy ascertainment and verification. Not so, however; nothing that goes into the making up of a really great atlas should be considered of minor importance—either a fact, or a date, or a name must be mentioned exactly as they should be, or else not mentioned at all. No conscientious editor will content himself with uncertainties, but will follow out every possible clew until he has reached scientific accuracy in every particular. Although the statement will sound to the reader as an exaggeration, it can be emphatically asserted that over sixty principal works of reference must be kept close at hand by the editor during this work and perhaps nearly as many more will be called into consultation during the preparation of one of these chapters of geographical description. And, kept near at hand, what are not the difficulties of the situation when the subject under consideration is a distant and perhaps little known land? Then, if all this is necessary for a nearby state, all these books of reference must be gathered together and moderately speaking, they are increased tenfold.

Perhaps even greater care must be taken with the statistical tables, charts, and diagrams which have come to be an important feature of the complete and modern atlas. The figures which enter into these are gathered from many and widely separated sources, from the reports of the Treasury and other departments, those of the Foreign and Home Offices in England, and like offices in other countries, and even the reports of the now famous Sir Robert Hart, Chief of the Chinese Customs Service, and the English, Dutch, and German reports, regarding the little known islands in the far-off seas, must be carefully scrutinized for the information upon which these statistics are based. Then the most careful and oft-repeated calculations, verified at every step of the way, follow; and thus, little by little, are built up the various items which go to make up the completed table of statistics, or a gathering of those colored diagrams, which even better than statistical tables set before the reader the relative importance of various items of trade and produce in the world's great countries.

To a mind trained in astronomy and in touch with the latest discoveries in that marvelous science must be handed over the department which produces the charts and maps of the heavens and the accurately worded descriptions of these; and to a man of like experience in the history of the world must be relegated the chronological tables and the historical maps which have become of such importance in the eyes of many readers.

Having followed me thus far, the reader may be inclined to think that I have mapped out simply an ideal atlas, and say to himself that nothing of this sort is obtainable in America. This conclusion, however, will be erroneous. Up to the present time nothing so complete as here outlined has been published, but at this moment there is on the press, to appear perhaps as soon as this article sees the light, an atlas which is planned along exactly these lines, and in which the intense desire for absolute accuracy of maps, for particularity and precision of description in all of the departments here mentioned, for complete indexing and gazetteering, and beyond all of these for a superb series of illustrations of the world's striking scenery and notable places, such as has never yet been attempted in any atlas, have been the governing principles.

For thirty-four years the atlases and geographical publications of the house of George F. Cram, of Chicago, have had a great and growing sale all over this continent, and with each revision it has been the publisher's attempt to introduce improvements and innovations which would distinctly enhance the value of his various atlases. For the editions which are now on the press, both of the larger "Standard," or Commercial Atlas, devoted mainly to the shipping interests and those of the mercantile world in the United States, and "Cram's Atlas of the World, Indexed," a fuller and more thoroughly trained staff of editors and assistant editors have been employed than ever before. If college degrees, memberships in learned societies, travel experience, long training in literary fields, and in the even more difficult fields of exact research and verification promise anything whatever, then Publisher Cram has gathered around him and under his direction a force of men who are well able to make these publications all that he has planned for them, and feels free to promise to the public. The writer has had unusual opportunities to know some of these editors, to know something of the intimate work of themselves and their assistants, and to inspect the methods by which accuracy and precision have been aimed at, and he believes that without any possible ground for questioning these atlases, and especially the more complete "Cram's Atlas of the World, Indexed," mark a step in advance, in geographical publishing in America, which it will be difficult for rivals to soon reach, and which far surpasses anything heretofore attempted.—Cram's Magazine.

MANUFACTURE OF PORTLAND CEMENT IN CALIFORNIA.

By EDWARD BOOTH, University of California.

THE discovery of practically unlimited quantities of petroleum in California has already greatly affected the industries of the State, and gives promise of further very important effects in the near future. Manufacturing enterprises in California have always been discouraged by the lack of an abundant and cheap fuel. Good coal is not found in the State, and that imported has always been held at prices high enough to prevent its use in cases where small profits had to be considered. The California oils have not yet, as a rule, proved as good for illuminating purposes as for fuel. For heating they are far superior to California coal and far cheaper. Many large manufacturers of the State were quick to realize this advantage, and already large quantities of oil are used for the production of power in places where a year ago coal was the only fuel.

The appearance of a cheap and convenient fuel has called attention to the latent possibilities of many of the hitherto undeveloped resources of the State, resources that have always existed, but that could not be profitably developed under the old coal regime. This is notably the case with Portland cement. The demand for this material is almost unlimited and is rapidly growing, yet California's product to this time has been inconsiderable. Ten years ago the imports of foreign cement at San Francisco amounted to nearly half a million barrels in a single year. Since that time there has been a steady but not rapid increase in the amount of foreign cement imported, the American article having replaced it to a considerable extent, yet so greatly has the use of cement increased that in 1900 the importation of foreign cement into San Francisco amounted to over 572,000 barrels.

The amount of American cement employed in the State has been steadily increasing in the past few years just in proportion as its manufacture in the United States has increased. But California itself has done very little to satisfy its own demands. It has imported cement from England, Germany and Belgium by the hundreds of thousands of barrels, and has brought large quantities from the more eastern parts of the United States. Even Utah has contributed its share, one of the recent large contracts of the San Francisco Harbor Commission having been captured by a Utah cement company.

California has enough cement-making material within its borders to supply the whole world. Yet it has hitherto practically made none for itself, but has gone as a purchaser to markets half way around the earth. When coal was the only fuel there was an excuse for this, but this excuse exists no longer. California can now make all the cement it needs and do it at a profit. All that is necessary for the successful manufacture of Portland cement—the demand being sufficient—is that raw material and fuel should be available in sufficient quantities and at a cost sufficiently low. There has never in California been any question as to raw material. That exists in unlimited quantities. The fuel has been the unsolvable part of the problem.

Portland cement is made of limestone and clay. Chemically, these two ingredients are the only ones necessary. The physical characteristics of the two constituents have a direct bearing on the cost of manufacture, a soft, easily powdered clay and limestone being manipulated more cheaply than harder materials. In California both hard and soft occur; the limestone of the eastern part of the State being as a rule harder than that along the coast. These coast deposits are very large, one of them, a few miles south of San Francisco, having supplied that city with lime for many years. And, what is equally advantageous, clay occurs closely adjacent to the lime. In the report of the State Mineralogist of California several years ago, attention was called to this juxtaposition. He said: "In every section where limestones are found on the coast it may be noted that clay or shales are found in close proximity."

But while clay and limestone are abundant, fuel has always been expensive and scarce. In making Portland cement a high temperature is needed, and a correspondingly large amount of fuel is necessary. The mixed limestone and clay must be heated to the point of incipient fusion. In most places in California otherwise adapted to the manufacture of cement, it has hitherto been impossible to obtain the necessary fuel, the cost of a sufficiently good coal being actually prohibitive. Now, however, the production of oil seems to have solved the fuel question, and there is no longer any reason why Portland cement should not be made in California sufficient in quantity not only to supply the State's demand, but also to furnish cement to our American neighbors and to more distant Asiatic acquaintances. The difference in the cost of labor in California and the cost elsewhere is not very important and may be disregarded, as it is far more than counterbalanced by the cost of transportation and duty on the cement brought into the State.

There have been various attempts heretofore to manufacture cement in California, but with a single exception they have proved financial failures. The cement was all right as to quality, but the manufacture did not pay. The one exception is at Colton, in the southern part of the State, where several years ago the California Portland Cement Company erected works that have been in successful operation ever since. The first manufacture of cement in California dates back to the old romantic times of the missions, when the Spanish padres burned the clayey shell limestone of the coast and used it for mortar. At the mission of San Fernando cement made in this way and used with broken stone in the form of concrete was employed in the construction of a reservoir dam a hundred feet long, twenty feet high and twelve feet thick at the base. This shell limestone consists approximately of 75 per cent of limestone and 25 per cent clay, and should make a fairly good cement if properly burned.

Various attempts were subsequently made in different parts of the State; one of the most promising for a while being at Santa Cruz, on the coast south of San Francisco and not far from that city. Soft chalky limestone, with extensive clay beds close at hand, supplied all necessary raw material. Analyses showed both lime and clay to be of excellent quality. Twenty years ago a company began manufacturing cement at this place and met with complete success as far as the quality of the cement was concerned; but the manufacture proved unsuccessful financially and was abandoned. Another attempt was made about the same time at the town of Benicia, on the upper part of San Francisco Bay. At this place natural rock cement was made, suitable material being found near by. To test the quality of the material several hundred barrels of the cement were made and were used in the foundation of the City Hall of San Francisco, where it gave complete satisfaction. But this enterprise, like its Santa Cruz contemporary, proved unsuccessful financially and was given up. Attempts continued to be made at different places, but all failed financially until the works at Colton were established. At that place, for the first time, modern machinery and methods were employed. Revolving oil-burning furnaces and other appliances such as are used elsewhere in the United States were set up, and the enterprise is reported to be in a flourishing condition. It probably owes its success to its cheaper fuel and to the use of improved machinery.

There has of late been a decided revival of interest in the Portland cement manufacturing business, and preparations are being made in various localities to establish cement works, oil to be used as fuel. The most ambitious of these is near the town of Tesla, in Alameda County, a few miles from San Francisco. Clay and limestone of exceptional purity are found there, and, in addition, one of the few coal mines of California is located at the same place; while, if the coal should not be found suitable as a fuel, the oil fields are within available distance. This company proposes to build works capable of turning out five hundred barrels a day, and with a possibility of increasing this output to a thousand barrels.

The original owners of the Benicia works are now figuring on the cost of a modern plant at that place and contemplate the use of oil fuel. This town is on tidewater and could ship directly to San Francisco or to any deep-water port. Besides these two there are rumors of the establishment of Portland cement works at a number of other points in the State where the proper conditions exist and where the oil fuel can easily be obtained. The only thing that has delayed the building of such works is the inability of the average Californian to realize that cheap fuel actually exists in his State. He has so long been accustomed to regard coal as a bugbear in all manufacturing enterprises that it is taking him a little while to appreciate his good fortune. California is at present occupying a position at the rear end of the procession as a cement producer, but unless all signs fail the State will soon take a more honorable position, and will be manufacturing a large part, if not the whole, of what it consumes.

AN OUTLINE OF THE PROGRESS OF CHEMISTRY IN THE NINETEENTH CENTURY.*

CHEMISTRY is one of the youngest of the natural sciences. Its growth and development have taken place almost entirely in the past one hundred years. Nevertheless, it is well to remember that some of the foundation stones of the science were laid in the latter part of the eighteenth century. There was no such thing as a science of chemistry in the time of the ancient Greeks and Romans. Nor during the middle ages, nor previous to the year 1750 can there be said to have been any systematized chemical knowledge.

In the middle of the eighteenth century the attempt was made to explain in a general way that most striking of all ordinary chemical changes, namely, fire or combustion. It was noticed that there are two classes of bodies, those that will burn and those that will not. The former were assumed to contain the element of fire, or phlogiston. In the process of burning the phlogiston was supposed to escape into the air; the ashes or products of combustion remained behind. The act of burning was looked upon as a decomposition. Combustible bodies were all supposed to be of a compound nature, consisting of phlogiston and the products of combustion. In the act of burning these two elements separated, the phlogiston going off into the air, the products of combustion remaining behind as the ashes.

This first theory of chemistry was replaced by a better one in the year 1785 by Lavoisier, the distinguished French chemist. Last summer a bronze statue of Lavoisier was unveiled in Paris. It bears a single inscription, namely, "The Founder of Modern Chemistry." Lavoisier found that when bodies burned the products of combustion were heavier than the original substances. A few years previous to this, in 1774, Joseph Priestley, the English clergyman, had found that when the red calx of mercury is heated oxygen gas is obtained, and that substances burn very brilliantly in this gas. Lavoisier repeated the experiments of Priestley, saw, what the latter failed to see, that burning was the union of oxygen with the burning substance and that combustion was a chemical combination and not a decomposition. "There is no such thing as phlogiston, the element of fire," said Lavoisier; and from this time on all substances that could not be resolved into simpler substances weighing less than the original substances were called elements.

Thus began a new era for chemistry, a quantitative era, in the year 1785. From now on the balance became the chief instrument of chemical investigation. Such in brief was the condition of chemistry one hundred years ago. The ideas of Lavoisier had, at the opening of the last century, come to be very generally accepted, but very little was known beyond these. Oxygen was the chief element and the oxides the chief compounds or, as Berzelius said: "Oxygen was the center point about which chemistry revolved." The knowledge of the composition of other substances was very imperfect. It was not even known at that time that substances do have a fixed composition; indeed, the fundamental laws of chemical action were still all undiscovered. Almost nothing was known of the composition of substances of vegetable or animal origin, that great and important class of bodies that we now know as organic substances. A century ago it was not known that alcohol contained oxygen; this fact was found out in the year 1809. There were no laws and principles, no generalizations; chemistry consisted of purely descriptive matter, and that was often very imperfect. Inorganic chemistry was largely mineralogy, organic chemistry was chiefly botany.

Limited as chemical knowledge was when the nineteenth century opened, there were, however, certain men at work, who had adopted the quantitative methods of Lavoisier, and who soon made important discoveries. First of all Proust, in 1801, announced that every chemical compound has a fixed and definite composition, that when substances unite chemically they do so in definite ratios by weight. This statement of Proust's was not allowed to go unchallenged. C. L. Berthollet maintained that compounds have a variable composition, and that if there are any that do appear to have a fixed composition it is an exception and not the rule. For eight years the controversy was carried on between these men. Proust finally came out victorious. More and more analyses of compounds were made until it was clearly established that every distinct substance has a fixed and unalterable composition. The second great law of combination was discovered in 1804 by John Dalton, and it is commonly called the law of multiple proportions. To explain these laws of combination, Dalton introduced the atomic theory into chemistry, and from now on the great problem was to determine the relative weights of the atoms. When the history of chemistry in the nineteenth century comes to be written, it will be largely the history of the atomic theory, and for more than sixty years the two great problems to which the most eminent men gave their attention were the determination of the atomic weights and of the arrangement of the atoms in compounds. It would be a long story to trace out step by step how these problems were solved. The men who did most in this direction were Berzelius, Dumas, Liebig, Gerhardt and Laurent, Cannizzaro and Kekulé. As a result of their work, it began to be generally recognized, about 1865, that these two problems had been satisfactorily solved, and from that time on there has been no question as to the reasoning employed in fixing upon a number to represent the atomic weight of an element, or to determine the way in which the atoms are linked together in a compound.

Side by side with this development of chemical theory has gone the discovery of new elements and compounds. Instead of the thirty elements or simple substances known at the beginning of the last century, we now have seventy-eight. Instead of a few scores of distinct compounds of definite composition, we now have thousands of these substances. To-day there are known 75,000 compounds of carbon alone. In the years 1859 and 1860 Bunsen and Kirchoff devised the spectroscope, and it has become, next to the balance, the most important instrument of chemical investigation. By means of it the elements rubidium, cesium, thallium, indium, gallium, scandium and helium have been discovered.

THE PERIODIC LAW.

Soon after the atomic weights had been determined satisfactorily, a very remarkable relationship was discovered by Lothar Meyer and Mendelejeff to exist between the atomic weights and the properties of the elements. It was found that when the elements were arranged in the order of increasing atomic weights, beginning with the lowest and going up regularly to the highest, there was a periodic variation in the properties of the elements. For example, it was noticed that the eighth element resembled the first, the ninth was analogous to the second, and so on. Mendelejeff expressed this fact in the following way: "The properties of the elements," he said, "are a periodic function of their atomic weights." By means of this law Mendelejeff was able to foretell the existence of new elements and to predict their chemical and physical properties. When the table of elements was first arranged it was incomplete, there were blank spaces. Mendelejeff predicted that elements would be found that would fill these spaces, and from the properties of the adjoining elements he foretold the properties of the unknown elements. In this way he predicted the properties of an element that would resemble boron, another that would be analogous to aluminium, and a third that would be closely related to silicon. These predictions have all been fulfilled. In 1879 Nilson discovered scandium, and found that it had all of the properties of the unknown element that resembled boron. In 1875 Boisbaudran discovered gallium; it was the element resembling aluminium, and in 1885 Winkler discovered germanium; its properties were almost identical with those that had been predicted for the element resembling silicon.

NEW ELEMENTS FOUND IN AIR.

In the last few years it has been found that ordinary air contains some elements, the existence of which had not even been suspected. For nearly three quarters of a century it was supposed that we knew all about the composition of the air, but in 1892 Lord Rayleigh found that a globe filled with atmospheric nitrogen weighed more than the same globe filled with nitrogen made from chemical compounds containing nitrogen, and this observation followed up led to the discovery of argon, an inert gas, present to the extent of about one per cent in the air. Then efforts were made to find argon in mineral substances; certain minerals that were supposed to give off nitrogen on heating were heated in vacuous vessels and thus helium was discovered. Recently Prof. Ramsey has found two other inert gases in air besides argon; he obtains them by the fractional evaporation of liquid air, and he has named them neon and kripton. Quite recently it has been claimed that the mineral pitch blende contains the elements radium, polonium and actinium, and that these elements emit rays that are capable of producing skiagraphic images on sensitive plates, and of discharging electrified bodies.

PROGRESS IN INDUSTRIAL CHEMISTRY.

Hand in hand with the development of scientific chemistry and the discovery of new compounds has gone the improvement of manufacturing processes and the methods of industrial chemistry. At the beginning of the last century potash was the chief alkali, and this was obtained from wood ashes. Leblanc invented a method of obtaining soda from salt, and for many years this was the only way of getting alkali on the large scale. Now this method has been almost entirely replaced by the Solvay or ammonia-soda process, and it is very probable that before many years this in turn will be replaced by the electrolytic process of obtaining alkali from salt solutions. There is a constant evolution of new methods in chemical industry, the older processes have to give way to more economic and perfect methods. For more than one hundred years, all the sulphuric acid that is used has been made in lead chambers, and one improvement after the other was added to this process until it was brought to a high state of perfection; but now, with the opening of the new century, the sulphuric acid manufacturers are pulling down their lead chambers. A new and better method of making the acid has been devised. Sulphur dioxide and air are led over finely divided platinum and the resulting sulphur trioxide is conducted into water. It has long been known that sulphuric acid can be made in this way on the small scale in the laboratory, but it is only recently that the principle has been adapted to the commercial preparation of the acid. Heretofore the difficulty has been that the contact substance, the finely divided platinum, soon lost its activity. Now it has been found that this can be overcome by carefully purifying the gases before they come in contact with the platinum, and that, by keeping the temperature of the interacting gases below the point of decomposition of the sulphur trioxide, the action can be carried on indefinitely and on the commercial scale. The resulting sulphur trioxide is led into water and sulphuric acid of any degree of concentration obtained.

Other important changes in industrial chemistry have been brought about by the application of electricity to the preparation of chemical elements and compounds. Places like Niagara Falls that have abundant water power for the production of electric currents are rapidly becoming the seats of important chemical industries. The electric current is at present used chiefly in two ways in inorganic chemistry. First it is used for the production of very high temperatures in the electric furnace. In simple form the electric furnace consists of a box of fire bricks in which the carbon poles of an electric arc light are placed. Under the influence of the high temperatures produced between the carbon pencils nearly all metal oxides are reduced by carbon. Aluminium oxide is reduced in this way at Niagara Falls, and aluminium bronze, an alloy of aluminium and copper, is made. Sand is reduced in the same way, and the element silicon unites with the excess of carbon and forms the compound carborundum, an exceedingly hard substance which is used so extensively as a substitute for emery. Artificial graphite and phosphorus are also made in the electric furnace and the carbides of a large number of metals have been prepared. Of these carbides calcium carbide has become of commercial importance, as it is used extensively for making acetylene.

The other way in which the electric current is utilized is for the electrolysis of liquids, either solutions of substances in water or fused substances. At Niagara metallic sodium is now made by the electrolysis of fused caustic soda. One of the uses of the metallic sodium is to prepare sodium peroxide, the new bleaching agent, for which purpose the metal is burnt in dry air. Metallic aluminium is obtained by the electrolysis of aluminium oxide in a fused bath of cryolite. Caustic soda and chlorine are made by the electrolysis of salt solutions, and potassium chlorate by the electrolysis of potassium chloride solution. The electric current is also used in refining certain metals, for which purpose sheets of the crude metal are suspended at one pole in a bath of the metal salt and the pure metal deposited at the other pole.

During the past century great progress has been made in the methods of extracting the metals from their ores. Not only has this been true of iron, but of all the useful metals. As an example, it is only necessary to call attention to the cyanide process of extracting gold and silver. Gold and silver ores which are so poor that it was unprofitable to work them in previous years are now successfully treated with a solution of potassium cyanide, which has the power, in the presence of air, of dissolving the noble metals. It is this method which has largely contributed to the increased production of gold in recent years. Side by side with this improvement of metallurgical processes has gone the utilization of by-products. Not only is blast-furnace slag used in making Portland cement, but other slags, such as those obtained in the basic steel process and which contain phosphoric acid, are used as fertilizers. The sulphur dioxide formed by roasting lead and zinc ores is no longer allowed to escape into the air, but is converted into sulphuric acid.

PROGRESS IN ORGANIC CHEMISTRY.

But undoubtedly the most rapid strides in the development of chemistry have been made in the past century in that department known as organic chemistry. One hundred years ago our knowledge of the compounds occurring in the organs of plants and animals was very meager indeed. A few organic substances had been isolated, but their composition was very imperfectly known, as the methods of analysis were very crude. Liebig in 1830 improved the method of analyzing these compounds and thus laid the foundation of organic chemistry.

A century ago it was generally believed that organic compounds could not possibly be made artificially by synthesis in the laboratory, as was the case with mineral compounds. It was thought that a peculiar vital force in some way intervened in their production in the organs of plants and animals, and that we could never expect to prepare them in the laboratory. But this idea soon had to be abandoned, for in 1828 Wöhler succeeded in building up urea from simple inorganic substances, and thus the first synthesis of an organic substance was effected. This was soon followed by that of acetic acid by Kolbe, and then year after year an ever larger and larger number of substances was added to the list of synthetic compounds. It would take too long to enumerate all the compounds that have been made artificially in the laboratory. It is enough to say that the hydrocarbons of petroleum, common alcohol, wood alcohol, fusel oil, the ethers, the ethereal and essential oils, the fatty acids, glycerine, grape sugar and fruit sugar, coloring matters and dye stuffs like indigo and turkey red, aromatic substances like oil of bitter almonds, vanilline and coumarine and many others, have been made.

One hundred years ago it was generally believed to be impossible for two substances of entirely different properties to have the same composition. When Liebig in 1823 found that Wöhler had analyzed silver cyanate, and stated the percentage composition, he saw that it was identical with the percentage composition of silver fulminate as found by himself. He at once wrote to Wöhler and told him that he must have made a mistake. Silver cyanate and silver fulminate were very different substances, he said; they could not possibly have the same composition. Wöhler repeated his analyses and found that they were correct. Liebig again analyzed silver fulminate and found that his figures also were correct. Both substances had the same percentage composition. A few years after, Berzelius showed that racemic and tartaric acids have the same composition, but different properties, and from this time on substances of this kind have been called isomeric. This phenomenon of isomerism, so rare at one time, is now very common. We have, for example, 55 substances having the formula $C_6H_{10}O_5$, all having the same elements in the same proportions, or the same kind of atoms and the same number of atoms of each kind. To explain isomerism it was necessary to assume that in these different bodies the atoms are differently arranged or grouped. Thus there came into chemistry the idea of structure or constitution, and by this term is meant the way in which the atoms are united to form the smallest particles of compounds. By studying the methods of formation and of decomposition of compounds it has been found possible to draw conclusions as to which atoms are more closely associated with one another. In the year 1865 the methods of determining the constitution of substances had been brought to a high state of development as the result of the work of Prof. Kekulé in Bonn. Kekulé proved experimentally that in a compound each atom is not united directly with all the other atoms, but that certain atoms act like links in a chain and hold different atoms together to form definite structures.

The immediate effect of this theory was that it led to a great deal of work, the object of which was to determine the way in which the atoms are linked in different substances. When once this structure had been determined, it was easy to see how the compound might be built up from simpler substances. The outcome was that hundreds of substances were made synthetically, and in the attempt to make artificially the valuable and useful substances, very often new ones were discovered that in turn were found to possess

* Address delivered before the Academy of Science at St. Louis, on March 18.—Science.

valuable properties. For instance, after determining the constitution of atropine, Ladenburg, in making it synthetically, succeeded in making several modified atropines, such as homoatropine, which also have valuable properties. Prof. Fischer attempted to unravel the structure of grape sugar and to make it synthetically; he succeeded in this, but in addition he has made twenty other sugars that had never been known before.

As work went on in organic chemistry and the methods of working with these substances were improved, and the means of distinguishing between them became more refined, it was found that there were even finer kinds of isomerism than had at first been observed. It is possible to have two or more substances of identical composition and of exactly the same chemical behavior, but differing from one another in only a very slight way. For example, one compound will rotate the plane of polarized light a certain number of degrees to the right while the other will rotate the plane the same number of degrees, but to the left. In short, there are right and left handed compounds. This physical isomerism, as it is called, can only be explained by assuming a different arrangement of the atoms in space. Since 1888 a great deal of work has been done in the development of the theories of space chemistry or stereochemistry. We are in a position now not only to determine how the atoms are linked to one another, but also how they are actually grouped in space. Stereochemistry is the most attractive field of research in organic chemistry to-day. Prominent among the men who have contributed to this department of chemistry are Van't Hoff, Wislicenus, Baeyer, and Emil Fischer.

PROGRESS IN PHYSICAL CHEMISTRY.

During the past fifteen years the borderland between chemistry and physics has been very successfully cultivated, and a new department of chemistry has resulted. This is the department known as physical chemistry, and it deals with such subjects as thermo and electro chemistry, with chemical statics and chemical dynamics and with the laws of solution and electrolytic dissociation. A great deal of progress has been made in all these directions. It is especially the new theories of solution and of electrolytic dissociation that have most profoundly changed our ways of looking at chemical action. We now regard a substance in solution as in a condition analogous to the gaseous state. Like a gas, the dissolved substance exerts pressure, and this pressure, which is known as osmotic pressure, obeys the same laws that gas pressure does. One great practical benefit that has resulted from the laws of solution is that it is no longer necessary to convert a substance into a gas in order to find its molecular weight; it is only necessary to dissolve it in some solvent, and from the changes which it produces in the freezing point or boiling point or vapor tension of the solvent to calculate the molecular weight.

The theory of electrolytic dissociation has greatly modified our ways of interpreting the ordinary reactions of analytical chemistry. We now hold that in all dilute solutions of acids, bases and salts—in short, the compounds of inorganic chemistry—we have no longer the unchanged substances, but their positive and negative ions. In the act of dissolving in water the acids, bases and salts are more or less completely split into their ions, and the chemical changes that take place in these solutions are reactions between these ions. A great many facts of analytical chemistry, of electrolysis and such empirical laws as the law of thermoneutrality of salt solutions and of the constant heat of neutralization of acids and bases, heretofore inexplicable, have now received a rational and natural explanation by means of this theory of electrolytic dissociation.—Edward H. Keiser.

PHYSIOGNOMY IN SAVAGE ART.

IN the reproduction of the human figure, the most difficult task is to render the physiognomy well. Owing to the labors of the great physiologist, Duchenne of Boulogne, we now possess albums of photographs that express the most varied emotions in the most accurate manner. Duchenne succeeded in electrizing the different muscles of the face locally, and thus decompounded and reproduced the most complex expressions of feeling at will; and then, fixing them by means of photography, he was able to furnish art with precise data. But in former times the artist had no photographed records at his disposal, and, in order to reproduce the expressions of the most fugitive emotions by brush or graver, was obliged to trust to his memory. So it is not astonishing that the art of early times produced as a general thing calm, expressionless and weak faces. This was the character of Greek art at its beginning, of Byzantine art, and of the art of the period that preceded the Italian Renaissance.

But popular art, crude and imperfect, had not the same reasons for showing itself deserved. It did not seek an exact copy of the physiognomy, but simply a few schematic lines that recalled it.

All treatises upon physiognomy, conscientiously copying one another, attribute to Hubert de Superville, in

FIG. 1.—A HAWAIIAN GOD OF WAR, WITH A FACE EXPRESSIVE OF CALM FEROCITY.

1827, the honor of having invented such delineations. He doubtless must be credited with having rendered them precise and of having reproduced them under a dogmatic form, but their origin dates back to the birth of art. They were invented by the first man who desired to reproduce the human emotions.

It suffices to visit a museum of ethnography in order to find, in savage art, the outlines that express joy and sadness. They may be observed in Neo-Caledonian art, the hideous masks of which present an arched mouth with an upper concavity; in the art of the New Hebrides, the huge tom-toms of which are rudely carved into the form of a human face with a wide, laughing mouth; and in the art of New Guinea, in which we find small statues that recall our "John who weeps" and "John who laughs."

Savage art, even, renders conventional expressions of emotion. The New Zealand warrior sticks out his tongue in order to express to the enemy his disgust and contempt. The rudest designs may omit features of prime importance, but the tongue protruding from the mouth as a sign of defiance is never omitted.

The finest emotional expressions are due to Hawaiian art. The figures that we reproduce are gods of war. These heads, hollow in the interior, were carried upon a pole, and their presence in combats assured victory. A cult was instituted in their honor, and hundreds of victims were sacrificed to these ferocious divinities. But at present the Hawaiians are so civilized and so thoroughly Christianized that they have totally forgotten these practices. With what care and infinite art these gods were manufactured is well known. The flora and fauna of the Polynesian Islands are extremely poor. Recourse was had to the aerial roots of the "ie-ie" (*Freycinetia arborea*) for the manufacture of a manikin, which was entirely covered with a netting of "olona," to which were fixed the red feathers of the "iiwi" bird. Then a few yellow and black feathers of the "oo" were added in order to make the features more marked. These birds were very rare and had to be captured in the mountains. In 1800, King Kaumualii gave orders that they should not be killed, but should be set free after they had been plucked. The material was, therefore, rare and valuable. The gods could not be made otherwise, and that is why the Hawaiians had idols made of feathers. Nothing was spared to embellish them, and especially to give them a real aspect. Sometimes human hair was fixed to their heads; but, in most cases, they were provided with the Hawaiian helmet with a huge crest that turned to one side and deadened blows. This helmet recalls, in every respect, that of the Greeks. The teeth of the idol were those of dogs, the eyes were of mother of pearl, and the pupils were represented by buttons of black wood.

These divine warriors, which, like the gods of the Iliad, accompanied their people in battles, possessed, almost all of them, expressive countenances. The first herewith figured is of a calm ferocity. Its eye is horizontal, and its open mouth shows sharp teeth. It is described in Cook's voyages.

The next (Fig. 2), preserved in the British Museum, forms a contrast. Its curved mouth expresses sadness. Its large eyes served to intimidate the enemy.

The third (Fig. 3), which likewise belongs to the British Museum, has a terrified aspect. Its large pupils are expressive of fright. The elevation of the two lateral parts of the upper lip is due to the action of the common elevator muscles of the alæ of the nose and of the upper lip, which express discontent. Ought not the sight of such a god cause fear in the enemy that contemplated it?

The last (Fig. 4) is "John who laughs," but it is a ferocious and sanguinary laugh, such as is fitting after the defeat of an enemy. It forms part of the collection of the museum of the Society of Missionaries of London.—For the above particulars and the engravings we are indebted to La Nature.

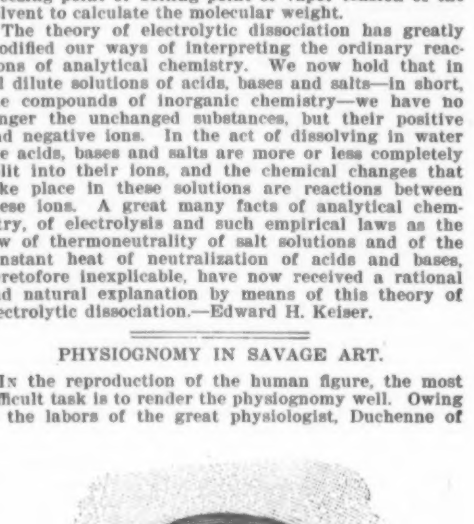


FIG. 2.—GOD OF WAR WITH A MOUTH EXPRESSIVE OF SADNESS.

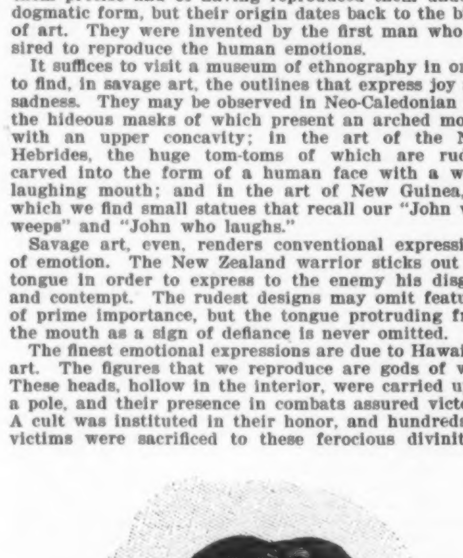


FIG. 3.—GOD OF WAR WHOSE MOUTH AND DILATED PUPILS INDICATE FRIGHT.

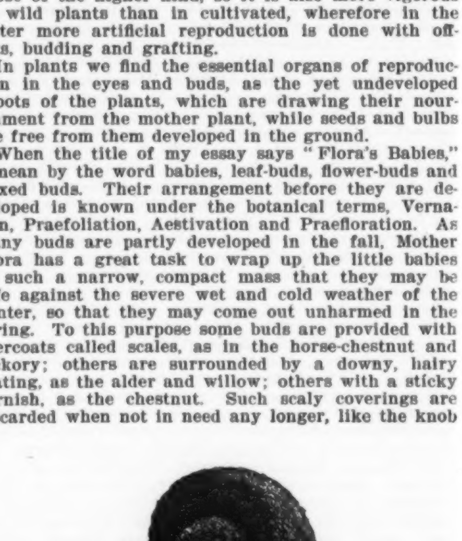


FIG. 4.—GOD OF WAR WITH A FEROCIOUS AND SANGUINARY LAUGH.

HOW MOTHER FLORA WRAPS UP HER BABIES.

REPRODUCTION is the aim and end of all activity in plant life, but it is different in so far from the reproduction in the animal kingdom as the reproducing parts of animals, the antlers in deer, feathers in birds, tails in lizards, pincers in crabs, are always reproduced in the same place, while such parts in plants are always reproduced in another place as the new leaf comes out in a different place from the old scar.

As the power of reproduction is always stronger in lower animals, as in polyps, crabs and lizards, than those of the higher kind, so it is also more vigorous in wild plants than in cultivated, wherefore in the latter more artificial reproduction is done with offsets, budding and grafting.

In plants we find the essential organs of reproduction in the eyes and buds, as the yet undeveloped shoots of the plants, which are drawing their nourishment from the mother plant, while seeds and bulbs are free from them developed in the ground.

When the title of my essay says "Flora's Babies," I mean by the word babies, leaf-buds, flower-buds and mixed buds. Their arrangement before they are developed is known under the botanical terms, Vernation, Praefoliation, Aestivation and Praefloration. As many buds are partly developed in the fall, Mother Flora has a great task to wrap up the little babies in such a narrow, compact mass that they may be safe against the severe wet and cold weather of the winter, so that they may come out unharmed in the spring. To this purpose some buds are provided with overcoats called scales, as in the horse-chestnut and hickory; others are surrounded by a downy, hairy coating, as the alder and willow; others with a sticky varnish, as the chestnut. Such scaly coverings are discarded when not in need any longer, like the knob on a chick's bill after the hard shell has been split open by it.

In mild climes no bud scales are said to be met with. This I doubt, as, for instance, our rubber plant shows a large scale which protects the young sprouting leaf not only against the northern cold, but also in southern regions against insects.

When we make now a more careful examination

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into the arrangement of buds by a cross-section, we find very different forms, that may be reduced to four principal ones, namely:

1. The plicated form, when a monopetalous corolla has been folded up lengthwise, and the plaits may be turned outward as in the bellflower, or inward as in gentian, or contorted like a paper bag as in the rubber plant, which on this account sometimes is called cigar-plant.

2. The next form is called the valvate form, when sepals or petals are touching each other by the margins, as the mallow, linden and grape.

3. The third form may be called the imbricated, when the outer part with its margins covers the inner one like shingles on the roof, as in veronica and flax, cranberry, carex, lilac and grass.

4. As the fourth form I can name the revolute, when the margin is turned outside as the petals of the umbelliferous plants, also called reduplicated. There are more forms and terms for them, but I think this may be almost too much. Every one of us knows that Mother Nature has numerous varieties to accomplish her aim and final design, and it is just this continuous variation which makes the study of nature so interesting, because we see not any more blindfolded at random but an eternal wisdom regulating the spherical harmony even in the smallest parts of plants and animals as in the grand starry orbs of heaven.—J. H. Lageman, in Journal of Columbus Horticultural Society.

LIVING BAROMETERS.

As the forecasting of the weather has always been a matter of prime importance to man, he has never failed to seize upon the most trivial fact that seemed to be of a nature to furnish him some indications upon the subject, and simple coincidences have often led him to erect into principles the results of ill-interpreted observations. But legend took possession of them, and there is nothing more difficult to eradicate than certain popular beliefs, notwithstanding science and demonstrated the untruth thereof, and especially when such beliefs had received the support of superior minds, as, for example, that regarding the tree-frog.

Dumeril, while professor in the Museum of Natural History, said in 1863:

"Tree-frogs announce rain by their croaking. A hygrometer or a living barometer may be made by putting one of these animals into a vessel in which care is taken to provide it with water and insects for its nourishment. It might be preserved thus for seven consecutive years. Provided in their glass prison with a small ladder, their ascent indicates that the weather will be dry. The approaching change of the latter is very often announced, too, as in the menagerie, by the noisy croaking of these animals."

Previous to this Marshal Vaillant, apropos of the discussion of a project for the establishment of numerous posts of meteorological observation throughout the entire extent of the empire and the French possessions in Africa, in dwelling upon the necessity of observations of this kind, maintained the same proposition by saying: "The frog of Father Bugeaud still enlivens the bivouacs of our soldiers in Africa. This great man of war, who has done so much for our colony, *ense et aratro*, always consulted his tree-frog before setting his troops in motion upon an expedition."

And yet, despite all, it has been experimentally proved that the tree-frog can furnish no serious information upon the weather to come, and even remains inferior, as regards this, to the simplest of ordinary barometers.

Will it be the same with some recent observations made by the celebrated entomologist, M. J. H. Fabre, upon very different animals—the Geotrupes? We shall refrain from answering; but we are certain of interesting our readers in borrowing from the author of "Souvenirs Entomologiques," the text of his observations. It is a question, let us say at once, of *Geotrupes hypocrita*.

"It is a belief in the rural districts," says M. Fabre, "that when the Geotrupes fly in large numbers in the evening, in keeping close to the ground, it is a sign that the weather will be fine on the morrow.

"For their work they require a warm and quiet atmosphere. If it rains, they do not budge, nor do they if it is cold or wintry."

In order to verify the value of this belief of country people, the eminent entomologist made some observations upon Geotrupes kept in cages, and thus sums up what he saw and noted:

"First case.—A superb evening. The Geotrupes flew about the cages impatient to hasten to their vesper-time labor. The next day the weather was magnificent. The prognostic was merely very simple. The fine weather of the next day was a continuation of that of the preceding evening. If the Geotrupes did not know of it for a longer time they scarcely merited their reputation. But let us pursue the test before concluding.

"Second case.—A beautiful evening again. My experiment seemed to recognize in the state of the sky the announcement of a fine day. The Geotrupes were of another opinion, for they did not come forth. Which was to be right, man or the insect? It was the insect, which, through the acuteness of its impressions, foresaw a shower. In fact a rain supervened during the night and lasted a part of the next day.

"Third case.—The sky was overcast. Would the wind, which was from the south, bring us rain? I thought so, so much did appearances seem to affirm it. Nevertheless the Geotrupes flew about and buzzed in their cages. Their prognostic was correct, for on the next day the sun rose radiant.

"Electric tension seems especially to influence them. On warm and heavy storm-breeding evenings I saw that they were still more active than usual. On the following days there were violent thunder-claps."

Finally, on the 12th, 13th and 14th of November, 1894, M. Fabre remarked an extraordinary agitation in his insects, and learned by the newspapers that on the 12th a squall of unheard-of violence had broken forth in the north of France and had afterward had its echo in the south. "Was there here," asks he, "a simple coincidence?"

Let us await with him until some new observations bring an answer, and let us conclude with a few lines upon the habits of the Geotrupes. Our figures will allow us to dispense with a description of them.

Under masses of cow dung they excavate vertical, cylindrical burrows that reach 8 inches in depth in summer, but nearly 3 feet in winter. The male and female form this excavation together. This is an exceptional phenomenon among insects, in which the male, as a general thing, does nothing. The male here remains at the bottom and piles up the dung passed to him by the female.

The provisions collected here are nearly 8 inches in thickness. In summer they are used as daily food; but, later on, there is remarked at the lower part a chamber of the size of a hazel-nut, in which is deposited a large egg that hatches at the end of one or two weeks. From this comes a white larva which is bent double and which eats in excavating a gallery through the mass of dung (Fig. 3). At the beginning of winter this larva descends and excavates a hole in which it lies dormant until April. Then it revives and again eats a little, and plasters the top of its abode with the excrement that it has accumulated, and then becomes transformed into a chrysalis, from which, four or five weeks later, emerges a perfect insect.

This larva is remarkable by reason of a third pair of legs, which are always atrophied (Fig. 2).

The oviposition takes place between September and November.

M. Fabre has also observed the influence of atmospheric disturbances upon the caterpillar of an insect living upon the pine. This makes its exit from the egg in September and lives in numerous groups of thick silken nests which it constructs upon pine trees, of which it eats the needles. It passes the entire winter in these nests, and makes its exit therefrom

FIG. 1.—GEOTRUPES STERCORARIA IN FLIGHT.

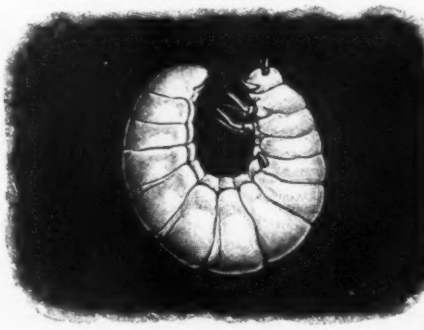

FIG. 2.—LARVA OF GEOTRUPES STERCORARIA.

at night only, in order to feed upon the neighboring branches. Now, when a barometric depression is about to occur, all the caterpillars remain in the nest and never venture out upon the branches, where the wind, rain or snow might surprise and kill them. They are provided with special organs, eight in number, that appear upon their back in January or at the moment of their second moulting. These consist of retractile tubercles which the animal extends at will through apertures. M. Fabre considers these organs as "meteorological apparatus."

The insects already mentioned are not the only ones that might furnish useful indications from a meteorological viewpoint. Bees are very sensitive to variations in the atmosphere, and are often seen, before unsuspected storms, in active motion near the entrance to their hive and refusing to leave the spot, although the sun is shining brightly. So, too, the *Epeira diadema* cuts certain threads of its web in order that the latter may give less resistance to the wind, and then conceals itself in some well sheltered place. Other spiders, the Tegenariæ, for example, retreat to the bottom of their tubular habitations and to the entrance of which they are observed to return as soon as the weather has become calm again.—For the above particulars and the engravings, we are indebted to La Nature.

THE ORIGIN AND GROWTH OF A FAMOUS WILD ANIMAL BUSINESS.

THE beginning of Jamrach's business belongs to Hamburg, where the grandfather of the present Jamrach was chief of the river police, says Chambers's Journal. In his official capacity he was in the habit of boarding arriving vessels, and so was attracted by the curiosities the sailors brought home. He took to buying such of those as took his fancy. Then his friends wanted him to procure similar curiosities for them, and thereafter his friends' friends were seized with the same desire. The upshot of all this was that he saw an easy and a profitable business in these rarities; for the more they were distributed the greater the number of people that wanted them, and the more he bought from the sailors the greater were the quantities they continued to bring him. Accordingly, he resigned his office in the police and announced to the public that he was prepared to supply them with rarities of any kind from any shore; for the crew of every ship that sailed were now practically so many agents for him. Wonderful shells and birds of gorgeous plumage were his chief commodities; for these there was a constant market, and as long as the sailors were well remunerated there was an ever increasing supply. It was not easy to glut the market with natural rarities in those days, for the world was wider than it is now, and the products of distant lands comparatively unknown.

Others soon entered the business, and, as there was always a market for a rarity, competition between the rival dealers centered round the sailors. The great point in the competition was to acquire early knowledge of the arrival of rarities on the docks; and, for this purpose the dealers employed the loafers round the quayside to "run" to them with such news, the "runner" being rewarded in proportion to the importance of the information he brought. I have seen the late Charles Jamrach pay a runner as much as £5, and I have seen him pay as low as one shilling. Besides employing runners, one dealer took to going out to meet expected ships; another dealer did the same, and went further next time. This was capped by other dealers going further and further. The next

FIG. 3.—BURROW OF GEOTRUPES STERCORARIA.

The male and female laboring together in storing food. At the bottom is seen an egg in the hatching chamber.

innovation was to steal away unobserved in the night—a trick that came out in the course of time, and then the rival dealers used to have one another's movements watched by night as well as by day.

CREATING A MONOPOLY.

The masterstroke that killed this irksome competition for the time being was inflicted by Jamrach when he sent his son Charles to London, there to reside and buy up the rarities and animals, and send them to him on the continent. This practically gave Jamrach a monopoly; for then, there being no Suez Canal, English ports were always those first touched by homeward-bound vessels. Enjoying this virtual monopoly, Jamrach could now tell captains of ships what to bring him without any fear of what they brought falling into rival hands. Thus it came about that if even a European monarch wanted a rarity—as did once the Emperor Joseph of Austria, who for years sought for what Jamrach got for him in as many months; namely, a lion with a particular kind of mane—his best plan was to go to Jamrach. Jamrach's accordingly became known as a place where anything could be procured, "from a needle to an elephant," as I have often heard it put. These were the good old times of the animal and curiosity trade, with an expanding world, so to speak, to draw supplies from; with people eager to know more and more of new countries; and with the institution and growth of menageries, of zoological gardens, and of museums. There was then a boom right along the whole line of the trade, and deals with long profits and small initial outlay were of weekly occurrence. Booms there are

still, now and then; but they are confined to particular objects or particular animals, and arise in rather odd ways sometimes.

At the time theosophy was attracting attention, for instance, a stranger dropped into Jamrach's shop. He was received courteously rather than cordially. "To tell you the truth," said Jamrach to me about the time, "I thought he was some dock clerk out of a job, and under the pretense of wanting some rarity, had come in to pass the time with a look round." People that come in just to have a look round usually begin by asking for some fanciful rarity, such as a parrot that can say the Lord's Prayer backward or do a sum in addition. This particular stranger began quite differently. Had Mr. Jamrach any symbols connected with the religion of Buddah? Mr. Jamrach had; and the stranger, being taken into the museum, bought various images and religious carvings. He then wrote out a check, and the name he put to it showed him to be the representative of one of the oldest families in England. This gentleman came several times after that, making similar purchases, and told Jamrach that he was furnishing a theosophic temple, and that he was endeavoring by a close study of the images and idols to discover the thoughts of the artists that produced them. How far he succeeded is not our concern. It is our concern simply to point out that articles that had lain in Jamrach's museum for a quarter of a century, perhaps more, and were considered unsalable almost, had a market value suddenly "precipitated" upon them by the far distant Mahâtmas.

PRIVATE ANIMAL COLLECTIONS.

From thus selling deities or delicate Japanese carvings, Jamrach may turn next minute to selling a panther to a showman, a python to a snake charmer, a monkey to an organgrinder, a rare deer to a duke. One morning last spring a gentleman came in to buy a brown Brahmin bull that he had heard of. He bought the bull, and then going round the stables, he took a fancy to a leopard. He bought that also. Then he bought two hyenas, four brown Russian bears, four Sambur deer, three Persian gazelles, some black swans, and emus. What was a Worcestershire squire—for so he turned out to be—to do with these animals? This question would seem to have arisen in his own mind on contemplating his purchase; for, turning to Jamrach, he suddenly remarked: "I'll tell you what I'll do. I'll build dens for them, and when they're finished, you come down and see that they are strong enough, and all right. Meanwhile, you keep the animals for me." This was agreed to, and in about a month Jamrach sent one of his men down to Malvern with the strange freight. Most people are fond of animals—fond of possessing them, at any rate; and if we all had country estates and plenty of money we should without doubt be often found indulging our fancy in quite as expensive a way as this Worcestershire squire. A notable example of this is furnished in the case of Captain Marshall, who died a few years ago. He had a wild animal farm in a meadow on the banks of the Thames at Great Marlow. Among his animals, which included the finest collection of cranes ever got together, were three or four elephants—I forget the actual number. Now and then, just for the fun of the thing, he would go up the river in tow of one or other of these. He had an old lion, too, that used to follow him by day like a dog, and sleep at the foot of his bed by night, until it took to licking his face when he was asleep. A lion's tongue is as rough as a file, and scarcely to be endured on the human hand, to say nothing of the human face.

Young men inheriting fortunes frequently begin to show their independence by heavy purchases in the animal world, and give a fillip to prices. One such appeared some years back with a fancy for snakes. One afternoon about this time I was having a quiet cigar with Jamrach in the back room that serves for an office. He was telling me of an extraordinary snake, reported to be twenty feet long, that he had lost through not going down to the docks as soon as he had heard about it and purchasing it. It had been brought over for Jamrach by the captain of a steamer from China; but, no Jamrach appearing, the captain grew nervous with it in his possession in the docks, and let it go for £12. "Foolish fellow!" exclaimed Jamrach. "If he had only waited just over night—for I went down the next morning—I'd have given him £40 or £50 for it. The strange thing about it, too, is that nobody knows where it has gone, and it's exactly a week to-day since it was sold." Not many minutes after he had thus spoken a runner burst in upon us. "Mr. Jamrach!" he cried excitedly, "do you want to buy the big snake?" "Certainly; and I'll give you a couple of sovereigns if I buy it." "Come on, then," returned the eager runner; "we haven't a minute to lose." Off they hurried in a cab. I afterward learned that the snake was remarkable for size, and proved to be the rare reticulated python from Java. The lucky purchaser of it for £12 had been holding it for £100. Being a man in a small way, he got apprehensive, and began to fear the snake might die on his hands as the £100 did not come as quickly as he had anticipated, so he had practically sold it for £40 to another dealer before Jamrach got there. The dealer was coming that very night with the money. "Here, my good man, is £45," said Jamrach on hearing the price he had been offered, "and I'll take the snake away with me now." "All right, sir; the snake is yours."

KANGAROOS NOW UNSALABLE.

There was a boom in kangaroos some years ago. It will be remembered that a boxing kangaroo was exhibited in London at the Aquarium. It drew such crowds that every other place of entertainment had to have a boxing kangaroo; but kangaroos were not to be had in such numbers, and some resorted to the clumsy expedient of clothing a man in a kangaroo skin. Even so, the demand remained unsatisfied, and cables were sent out to Australia to agents and the captains of ships lying there to bring over as many kangaroos as they could find. Kangaroos consequently, which before were practically unsalable, bounded up to £100 apiece; now they are again unsalable, and are heard of only in connection with a rather rich soup that is made out of their tails.

A leading animal buyer in this country is the Hon. Walter Rothschild. He is a keen naturalist, and buys everything that is specially rare. The results of his observations and investigations he publishes from the Tring Zoological Museum in his journal, "Novitates Zoologicæ." Not a week passes without telegrams or letters between him and Jamrach. It is the latter's habit, as soon as he lights on a novelty, to send off a telegram to a likely customer; and often an animal that has been traveling for weeks will be sent on a journey again an hour or two after its arrival, and when it has been seen to be all right. Once "Carnivora"—Jamrach's truculent telegraphic address—wired to a client that he had two lion cubs, just arrived, price £50. Would he send them? Back came the reply: "Don't want any live pups at any price," the first telegram having evidently been mutilated. To return to Walter Rothschild, he has for some years been making a special study of the cassowary, and the Christmas before last brought out a book on that bird, magnificently illustrated with colored plates. Very little is known of cassowaries; even experts cannot always tell the male from the female. On one occasion Jamrach sold a cassowary that all concerned regarded as a male. A few months afterward he received from his customer this telegraphic message, "Your male cassowary has laid an egg." Again, there are only some four or five species known to science. Walter Rothschild has established the existence of fifteen species. This has involved enormous outlay which no mere man of science could have borne. It entailed, to begin with, the purchasing of hundreds of live cassowaries, which sometimes cost as much as £150 each. Then these cassowaries, which were young birds, had to be kept until they came into color, the owner knowing all the time that he should derive no profit from his outlay. Previous students of the cassowary had to content themselves with the study of the mere skins, and could command only such skins as good luck might place in their way. Walter Rothschild, on the other hand, was able through Jamrach—whose hearty co-operation he recognized by presenting him with two copies of the elaborate book, which is for private circulation only—to institute a systematic search for cassowaries; and the officers of every ship that sailed from New Guinea and other haunts of the bird knew that good prices awaited them for every specimen they found.

There is always a more or less steady demand from zoological gardens for animals. Even collections that may be complete get broken into by death and require recruiting. To this extent death may be regarded as the friend of the animal dealer, but it is as often his foe. "There's £160 gone," said Jamrach to me once as he handed me a telegram. It ran, "Will accept tapir at £160," and was from Barnum & Bailey. The tapir had died two days previously. Jamrach succeeded in saving £10, however, which he got from an animal stuffer for the carcass. Sometimes, too, a dead animal can be used to feed other animals with. The vultures and hyenas, for instance, had the pleasure not long ago of feasting on a Ceylon pygmy bull worth £40. The last thing Jamrach does at his place of business before going home is to record the day's deaths in the deathbook. Opposite each animal he puts its cost price; and the losses reckoned on this basis run from £150 to £200 a month.

HISTORICAL GEOLOGY.*

By Prof. W. B. SCOTT, of Princeton University.

THE early conception of geology was simply to find out what the earth was made of and how these materials were put together, and in a general way simply to determine the processes concerned in bringing the earth to its present condition. Geology is one of the latest of the sciences; because into its study enter physics, chemistry, mineralogy, astronomy, botany and zoology—every one of which must be drawn upon in determining geological facts; and until these accessory sciences had reached a certain stage of advancement and perfection, geology was impossible. We get now and then in ancient literature a clever observation and a keen explanation of a geological fact; but no attempt was made to collect these facts and weave them into a whole; had it been in those long past ages it would not have done any good, because the means of interpreting those facts which other sciences supply to us would have been altogether lacking. As late as 1680 a learned German Jesuit, Father Kircher, living in Rome, wrote in Latin an immense folio called the "Subterranean Earth," to show fossils were merely imitations the earth made for its amusement. What he had seen as a traveler in the Caucasus were simply caverns of stalactites and stalagmites. He imagined he had caught nature in the very act of making these imitations of parts of animals and plants.

Professor Werner, at the Freiberg School of Mines, was first to show the earth was made of rocks disposed in a definite order and that things were not merely thrown together helter skelter; but he imagined they were there through frightful deluges, collisions with a comet's tail and all sorts of desperate and improbable agencies. The Scotchman Hutton argued: "Let's see what is happening now. Is the earth undergoing any change; if so, what? And what causes these changes?" He examined the work done by the atmosphere; by rivers, ice, volcanoes and earthquakes and concluded that all these supposed causes were totally unnecessary. He said: "Give me time enough and I will make the earth with precisely the same forces that are at work on it now." This, regarded as impious, took hold; but did not give us the history. Toward the end of the eighteenth century Baron Cuvier had his attention called to the number of skeletons of animals found in the gypsum quarries under the hill of Montmartre, outside of Paris. The finds were variously a single bone, sometimes a skull—a whole skeleton, etc.—all inclosed in the solid rock and laid down when the rock was forming. Cuvier had made what was then the greatest collection of skeletons in the world, and had familiarized himself with the bony structure of almost all kinds of toothed animals living now; and when the bones came out of the quarries he realized that the species were all extinct. That animals could actually die out and disappear was a new idea. Plenty of people had seen fossil shells, bones and plants; but had always taken for granted their kind was living now. The ferns in the coal beds—to any but a botanist—look like those growing in the swamps to-day; the shells in the rocks to all save the conchologist appear the same as those on the beach; and to one not a comparative anatomist one of these bones might readily be taken for that of some familiar animal. The announcement that these things were all gone—wiped out—was a thunderclap to worthy people, and a great many of the best educated concluded that it could not be true. In the transactions of the American Philosophical Society about 1811 occurs a paper by Thomas Jefferson, then President of the United States (eminent as a scholar and anatomist), wherein he describes a huge claw found on his Virginia estate which he believed belonged to some lion much bigger than an elephant. He argues against Cuvier's notion that anything could die out as being impossible—absurd—this gigantic lion must be living somewhere. To substantiate, he hunts up all the old wives' tales and hunters' lies that he could collect about frightful creatures that nobody had ever seen, with such terrific roars as to be heard miles away—he could prefer that particular kind of foolishness, rather than believe that anything could die out.

That fossils were unlike things that live now was the first step toward making geological history. William Smith, an Englishman, made the next step, putting the new science fairly on its feet. His occupation took him all over England locating and surveying coal property. He kept his eyes open as he went, and soon found out whether he was above or below the coal by observing the fossils in the rocks. Finding certain fossils on the ground, he knew there was no use looking for coal; finding others, he observed the chances were coal was deeper down; yet others, he knew it lay so deep it might not be commercially profitable to get it. From that he generalized the statement (literally true) that he could arrange the rocks in their chronological sequence by the kind of fossils he found in them. That was the key to the whole situation. That discovery once made, historical geology became a possibility and the immense amount of work done all over the world is simply an expansion of those great ideas enunciated nearly a hundred years ago, by Cuvier and William Smith. In the British Museum of London stands a marble bust of William Smith, surrounded by fossil collections which he made, together with his geological map of England—the first one ever attempted, and most interestingly accurate; because, made by a single man—a pioneer—its correspondence with the latest results is wonderful, in its general features, and a monument to Smith's genius.

Suppose some infinitesimal insect, living upon the paper surface of a six-foot globe, boring one-quarter way through the paper, were to set up a theory as to how this globe was made. He would be apparently (only apparently) about as near the truth as we shall ever be; because if you expand this globe the size of the earth, the thickness of the paper covering then is more than we penetrate into the earth's interior. The wrinkles on the skin of an orange magnified to the size of the earth would represent greater irregularities than the highest mountains and the deepest oceans—the highest mountain about 30,000 feet above sea level, the deepest ocean a trifle more below sea level. With a good margin of allowance, call the difference between ocean bed and mountain peak 10 miles, which is 1-400 part of the distance from earth's surface to its center. The diameter of a big orange call 4 inches—from surface to center 2 inches; 1-400 part of 2 inches is 1-200 of an inch; whereas, from the bottom of the groove to the top of the adjoining wrinkle is 1-50 to 1-60 inch. In other words, the orange skin irregularities are proportionately three to four times as great as the greatest topographical differences in the earth.

If the earth were made up of sheets of rock that ran around it concentrically, the greatest topographical differences would not expose much of their thickness to us; and what we could get at by boring would be very little—the deepest boring being a little over a mile—nothing at all if we had to study the earth as a whole. But earth needs not to be studied in that way. The facts are recorded on its outside; and it is in getting at those successive buried surfaces that our task consists: first, to get the records; second, to read them. We can get at vast depths of earth's surface without leaving the surface at all, because the beds of rock which make it are in many places turned up on edge. Taking a section across the eastern flank of the Alleghenies, you will find beds standing at high angles; so as you go across you can examine thicknesses of many thousand feet—just as, a book's leaves being originally horizontal, you can turn up their edges to view and, without piercing the book through, you can count its thickness by counting or measuring the leaves of which you see the edges. Sombody has called England "that wonderful epitome of geological history;" because, small as the island of Great Britain is, geographically, it represents almost all geological periods. It was most important that the first students of the science should get some conception of its vast scope; and they did it, because representatives of nearly all parts of the geological column there occur.

The rocks of different ages being exposed on the surface in different places, together with the fact of their being at many points turned up on edge, gives us the record. The lesson of the rocks is exactly as though you went into a library and found a vast number of imperfect copies of a history—no single copy perfect; but with so many different copies, what is missing in one is represented in another; and if you take the pains to compare all these copies and make a new one for yourself—putting in everything that you found in all the volumes—your story will be very nearly complete, provided the histories among them told all the story. What we have already done geologically is to get a very fair outline sketch of the world's history, involving, perhaps, hundreds of millions of years. As the examination of the world goes on and new countries are explored, the record gets more and more full; and when the earth is all as well known geologically

* Abstract of a lecture delivered at the Wagner Institute, Philadelphia. Prepared by special correspondent of SCIENTIFIC AMERICAN SUPPLEMENT.

as the west of Europe, and the east of North America, the record will be far more complete than we can make it to-day. To work out the geological structure in a small area represents an enormous labor. In Pennsylvania there is a vast deal unknown. Of its survey work so far done much is good, but a great deal very bad, and will have to be done all over again—which is true of most of our states. Of our whole Union, only the four States Massachusetts, Rhode Island, Connecticut and New Jersey have properly surveyed topographical maps. Three-fourths of the world is still known most imperfectly from the geological standpoint. With the progress of science we shall learn a vast deal of which we now know little.

The Egyptian hieroglyphics were inscriptions cut on tombs, obelisks and temples of Egypt—most attractive and beautiful, but nobody could read them. The French Expedition to Egypt found at the little village of Rosetta, in the Nile Delta, a stone on which there was an inscription in four languages: one, hieroglyphics; one, an unknown tongue in a running character; the third, Greek; the fourth, demotic or enchorial. It occurred to a great Frenchman that it was one inscription in three languages: he tried it and came out all right. There was the key to the study of the hieroglyphics; and from that beginning the scholars have gone on and now they can read Egyptian inscriptions with almost as much certainty as inscriptions written in English.

Where, then, is that Rosetta stone in geology? How are we going to get it? There are three ways. The first is the order of superposition of the rocks: the oldest must be at the bottom, the next in succession atop and so on. On the Baltimore & Ohio or the Pennsylvania Railroad, as they cut through the Alleghany Mountains, you see vast sections where the river valleys have cut and thousands of feet of rock are exposed to plain view exactly in their order. This is one of the most important and the first thing the historical geologist does in examining—he finds out the order of section. The next thing then is fossils, which are remnants of animals and plants (land and water) that existed during the time those rocks were laid down. Passing through a great thickness of rocks we find that the fossils of several thousand feet above where we began study have all changed—everything new. Fossils represent, first, continuity of life; secondly, that ever since the beginning of time living things have been changing; that this change is exceedingly slow, but, looking in perspective over such enormous stretches of time, they seem to be rapid. These changes are universal. While every sea coast has its own peculiar shells, yet, in a general way, the shells of the present time are alike and differ from those which went before. Similarly, while every continent has its own peculiar animals—just as you find the elephant, tiger and rhinoceros in India, the giraffe and hippopotamus in Africa, the bison in North America, and the sloth and jaguar in South America—yet there is a certain definite similarity about them: all of them evidently belong to the same order of time. In other words, we can read the geological age in terms of changes—and the changes went on in the same order in all the continents. We find precisely the same plants in our coal as in that of Great Britain; precisely the same plants in our uppermost coal in West Virginia as in the coal of Argentine Republic, India, South Africa, Australia—showing those were all contemporary. We find exactly the same fossils underneath the coal in this country as in England; the same fossils on the top of the coal, again, as we get there; so that if these changes did not take place at the same time they took place in exactly the same order of succession. That is a most important fact—because it leads right up to the conclusion that when you find rocks in different continents in the same folds, they were laid down about the same time.

This method, which is simply an expansion of the method discovered by Smith, and is the cornerstone of historical geology, must not be used too rashly. It has certain definite limitations. We must remember geographical differences. Compare two rocks—say here in the East and out on the Pacific Coast. The fossils are very much alike, and yet a little different. How shall we tell whether that is a geographical difference, due simply to the difference of distance between the two points, or to a difference in time? Sometimes you can tell, sometimes not. The change of life is not a haphazard one—it is a steady progression. The nearer we get to the present time in the records, the more like present life are the fossils; and so we are very often able to eliminate the effects of geographical distance by saying that one of these sets of fossils is a little more modernized than the other set—therefore, in all probability, a little later in date. The geologist makes the same use of fossils as the archæologist does of coins and their inscriptions, of the dates of buildings of which we have no written history. The town of Vesuvius was overwhelmed by the first historical eruption of Vesuvius in the year 79 A. D., and has preserved for us in the most marvelous manner the details of Roman life, sealed up for our edification for nearly 2,000 years. We have not a single contemporary notice of Pompeii's destruction. If we knew of Pompeii only from Roman history we would say there was some such place in the neighborhood of Naples that was shaken by an earthquake. Of the elder Pliny, commander of the Roman fleet in that time, who lost his life in that eruption because he was a man of science, and, going to look at it, was overwhelmed with gases and ashes, his nephew, the younger Pliny, writes two letters to his friend Tacitus, the historian, giving an account of the eruption, which he saw himself, and yet he says not one solitary word about Herculanem or Pompeii. How can we date anything about Pompeii, for we have no history of it? We can do it by this great catastrophe, whose date we know. Suppose we didn't know anything about the date of that overwhelming; in the absence of any mention of these towns in history, or of their destruction, the archæologist could do it within ten years by a careful study of the coins—of the inscriptions—of the style of the letters; because (though nobody intends to do it), handwriting, lettering, inscription writing and all that sort of thing changes from year to year, even nowadays. You recognize now eighteenth century handwriting; and a man familiar with manuscripts can tell you within fifty years the date of a manuscript he never saw before simply by looking at the handwriting. There is a little town in Western Germany near the French frontier with a most interesting building of Roman origin, now transformed and built into a cathedral. The great question among the archæologists was, what was that building originally—what did the Romans put it up for, and when? In the absence of anything very definite nobody could conclusively determine. A few years ago, in repairing up near the roof, they commenced to tear out some of the old Roman brickwork, and there, embedded in the mortar, was found a coin of the Emperor Valentinian. That building could not have been built earlier than Valentinian—it might have been built a little later, but probably not very much, because, as a matter of fact, the current coins are those which are not very old, especially copper coins. Take a handful of pennies out of your pocket: the generality of them are those coined within the last fifteen years. In countries like Great Britain, where the specie payments have not been interrupted for many years past, you will find the coins current there are those of recent date; therefore, that building could not have been very much older than Valentinian, and probably could not have been very much younger. So with the rocks and the character of the fossils occurring in the rocks; and, furthermore, as these changes in life and living things—animals and plants—took place approximately simultaneously, where you find rocks of similar character it follows they were laid down approximately at the same geological time. All that is needed is an expert knowledge of those facts in order to be able to read the inscription.

ASTRONOMICAL LABORATORIES.

THE grandest problems of astronomy have ever been problems of measurement. Descriptive observation may give us a picture of our solar system, and tell something of the apparent system of the stars. But purely descriptive astronomy knows nothing of absolute size and distance; it can furnish no predictions of the places of the heavenly bodies for the use of the navigator and the surveyor, no data by which to test and ultimately to justify the dynamical theories of the celestial motions. Such matters lie entirely within the scope of the astronomy of measurement.

Alike for their practical bearing and their grander interest, these problems of measurement claim to-day by far the larger share of the astronomer's efforts. But they demand for their solution powerful and costly instruments; and, as refinement after refinement has been added to the telescopes to meet the demand for higher accuracy, the work has fallen more and more into the hands of the great public observatories. Modest instruments cannot improve our knowledge of the distance of the sun and stars, nor lay down the positions of the stars in those great clusters which may show in the future evidence of cosmical change. While there are a hundred such paths of investigation lying open to the fortunate possessors of powerful telescopes, institutions and individuals more humbly equipped are forced to confine their efforts to certain narrow fields of activity.

And so long as the measurements are made at the telescope itself, by visual observation, progress is comparatively slow. Yet it should be remarked that the mass of figures which an observer accumulates in a night's measuring at the telescope is frequently more than he can deal with single-handed on succeeding days. Before the complete result is obtained the measures must be corrected for many determined sources of error, and there are long calculations to be performed. But with a moderate amount of assistance in the more mechanical parts of the calculation it has generally been possible to keep pace with the observations, and the time spent in the after processes bears a just proportion to the time spent at the telescope.

These conditions have been profoundly modified by the recent application of photographic methods to astronomical measurement. Let us consider, for example, the old and the new methods of surveying a cluster of stars. Of old the measuring apparatus was applied to the telescope, and the astronomer laboriously measured the distance from star to star until the whole group was triangulated. Frequently it was a matter of assiduous labor on every fine night for many months, during the whole of which time the telescope was fully occupied. Nowadays the measuring apparatus is removed from the telescope, and a photographic plate is placed in its stead. In a few minutes every star has left its mark upon the sensitive film; the plate is removed for development, and the work of the telescope is finished.

By the application of photographic methods the output of the telescope can thus be increased a hundred-fold. The time spent in laborious measurement upon the stars themselves has been saved for the nonce, and in a single night the telescope can record the positions of field after field of stars. It is not producing the measures themselves, but the raw material for after-measurement. The photographs which are amassed in such profusion must each be placed under a microscope, and the distance measured from image to image of the stars. The work is not so exacting as direct measurement at the telescope, for it can be pursued in the comfort of the library and in despite of cloudy skies. But still it is a long process, and there remains afterward an amount of calculation to be carried through at least comparable with that which was required in the old days of visual observation.

The position of an observatory equipped with a photographic telescope is therefore briefly this—that the power of the instrument to produce raw material is increased a hundred-fold, and the work to be done for every star after the telescope has dealt with it is perhaps doubled, because there is added to the calculation the work of measurement, which was formerly done at the telescope itself. But it is utterly impossible to multiply many-fold the computing forces of the observatory, to enable them to deal with the vast output of a photographic telescope in continuous work. There is no longer a just proportion between the time spent in the computing room and the time spent at the telescope, and the only possible course is to limit the use of the instrument to a few nights in the year, or to employ it in producing pictures which are not intended for subsequent accurate measurement.

Now this difficulty, which is so embarrassing to the well-found but often under-manned observatories, is a golden opportunity for those who desire to do astronomical work of the highest refinement, but have only modest means. The photographic telescopes that are at work can produce far more material in the shape of plates that can possibly be dealt with by the regular staffs of the observatories. They must call in help from without to aid in the labor of measurement and reduction of these photographic observations. And there should be no difficulty in securing this help when once it is realized how urgent is the call and how practicable the response. The sum which will buy the apparatus for measuring star photographs is small compared with the cost of equipping a very modest laboratory. For $500 the college which desires to found a school of practical astronomy, or the amateur who is anxious to spend his leisure hours in work of true scientific value, can be placed on terms of equality with the most magnificent observatory in the world, in everything but the power of producing the star photographs on which to work. Nor need there be any fear that these would not be forthcoming. There are already available tens of thousands of photographs accumulated in the first pride of possession of a photographic telescope, ere it was realized that the work of utilization could not keep pace with the powers of production. And there are many directors of observatories who have found themselves, to their keen regret, forced to limit the output of their splendid instruments, and who would rejoice over any increase in the power required to deal with the problems which could be attacked by photography, if only there were workers enough to carry on the work after the telescope had done its part.

There is nothing visionary in this estimate of the opportunities which photography has placed within the reach of would-be astronomers. Work of the highest value has already been accomplished precisely on these lines. Some years ago the Professor of Astronomy at the Dutch University of Groningen found himself with ample time for original work; but there was no observatory, and no money to build one. At the same time the Astronomer Royal at the Cape was completing a photographic survey of the southern sky, but the staff of his observatory was not large enough to enable him to measure the star pictures as they were obtained. The Dutch professor proposed to the astronomer at the Cape that the photographic plates as they were taken should be sent to Groningen, and that he should devote some years of his life to measuring the positions of the stars upon them, and preparing the catalogue of star-places which would result. The offer was accepted with enthusiasm; the plates were sent; and as a result there has recently appeared a catalogue of the positions of several hundred thousand southern stars, complementing the classic work which Argelander accomplished many years ago by direct observation for the northern sky. At first the professor worked at home. More recently he has obtained the use of a room in the physical laboratory of the university; a second measuring machine has been set up there; one or two students have joined in the work, and a beginning has been made of a wholesale determination of the distances of the stars, from plates which were taken especially for them by the director of the Observatory of Helsingfors. Such are the beginnings of the astronomical laboratory of Groningen. To its eminent director belongs the credit of being the first to build up a school of practical astronomy and a true observatory of first-rate power in a university which possesses no observatory in the hitherto accepted sense of the term.

And at least two enthusiastic amateurs have set up for themselves private astronomical laboratories, if we may use this very convenient name to distinguish them from observatories of the familiar type. The mathematical master at an English public school is engaged in determining the positions of formations on the surface of the moon from photographs lent by the Paris Observatory. And there is a gardener in the North of England who spends his evenings measuring the positions of stars on plates taken at the Oxford University Observatory for the catalogue of the great photographic chart of the heavens.

It cannot be too strongly urged that the only hope of utilizing the vastly increased powers which photography has given to astronomers lies in the multiplication of these astronomical laboratories. The work is pleasant; it can be pursued without any of the discomforts which attend working at a telescope in the cold and the dark; and it can be carried on regularly in despite of cloudy skies, which is a point whose importance can be realized only by those who have tried to work with a telescope during the past winter. There are many men who devote their leisure to astronomy and who have built for themselves small observatories. Not infrequently they have been keenly disappointed to realize that with their small opportunities they cannot add much to the sum of accurate knowledge, and they have grown tired of mere star-gazing. To such men photography has thrown open a field of boundless opportunity. If they are content to set up a measuring machine instead of a telescope, and to measure the star photographs which have been made at the great observatories, there is no limit to the aid which they can render to the progress of astronomy.

Let us take the case of a particular problem which is just now engaging the attention of astronomers all over the world. During the past winter the newly discovered planet Eros has come very near the earth. A great combined effort has been made to determine the distance of the planet. To this end thousands of photographs have been obtained recording the position of Eros among the surrounding stars. When they are completely measured and discussed we shall be in a position to deduce with great accuracy the distance of the planet, and that will lead to an improvement in our knowledge of the distance of the sun

from the earth, a distance which is of paramount interest, because it is the unit in which all other astronomical distances are expressed. But there is the ever-present difficulty to be surmounted. Far more photographs have been obtained than can be measured in a reasonable number of years by the astronomers who took them, even if they could afford to lay aside the photographic survey of the heavens on which they were before engaged, and to let their telescopes stand idle, producing no more results. There is fear that the new solution of the grandest problem in astronomy will be indefinitely delayed, and there can be no attack upon a hundred other problems which are pressing for solution, until it is realized by those who are in a position to help, that under the altered conditions introduced by the application of photography to astronomical measurement the necessary complement of each observatory equipped with a photographic telescope is a score of observatories of the new type, the astronomical laboratories.—Arthur R. Hinks.

INSTALLATION, OPERATION, AND ECONOMY OF STORAGE BATTERIES.*

By Ernest Lunn, Member Detroit Engineering Society.

Where the conditions are such that the demand on the central station is ever fluctuating and reaches a maximum in the winter time of three or four times the average load for only an hour or an hour and a half a day, which is the case in nearly all cities of the size of Detroit, a storage battery plant is a very valuable auxiliary.

This paper will deal with the battery plant of the Edison Illuminating Company, of Detroit, Mich., but before taking up that subject I wish to give a short description of the cell most commonly used in lighting and power stations.

There are several forms of cells, but all in commercial use are of lead plates in dilute sulphuric acid, and depend for their action on the formation of lead peroxide on the so-called positive plate and of sponge lead on the negative when a current is forced through the cell; which formations are reduced again, with production of a current in the reverse direction, as soon as the cell is free to discharge. The typical cell is merely two plates of pure lead in dilute acid. In practice the formations are facilitated by previous mechanical or chemical preparation of the plates. The mechanical preparation may be the slitting or grooving of the plates, to facilitate the electrical action by exposing more of the metal to the acid; but it is more often a careful determination of the plate structure, so as to secure and maintain the mechanical integrity. The chemical preparations are usually lead oxides or salts as part of the first construction, so that the work remaining to be done by the earlier electrical charges may be a minimum.

It should be noted that there is no electrical storage in a so-called storage battery or accumulator. The storage is of chemical energy, as in any electrical battery cell, and the difference between a common chemical battery and an accumulator is that in the latter the chemicals used permit a reversible cycle, the electric discharge being followed by an electric charge, which restores, with more or less completeness, the chemical energy which gave the discharge.

The chemical actions involved in the process of discharging and charging are very complicated, and have not been positively determined. The commonly accepted theory is that, on discharge, the lead peroxide on the positive plate is reduced to lead sulphate, while at the same time the sponge lead on the negative is sulphated, with the result that the sulphur radical is abstracted from the electrolyte, leaving it more dilute, hence of lower specific gravity.

A reversal of conditions takes place during the charging process. Oxygen and hydrogen are liberated by the electrolytic action of the current, which is forced through the cell in opposite directions to that of the discharging current. Oxygen unites with the sulphate of the positive plate, converting it into lead peroxide and liberating the sulphur radical, which goes back to the electrolyte, increasing its specific gravity. Hydrogen is freed at the negative plate, and decomposes the sulphate of lead on that electrode, reducing it to pure lead. The sulphur returns to the electrolyte, further increasing its specific gravity.

* From the Journal of the Association of Engineering Societies.

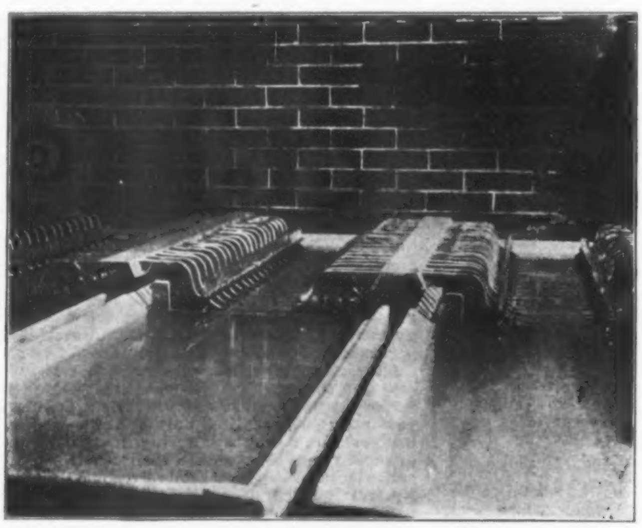

Fig. 1.—STORAGE BATTERY TANKS.

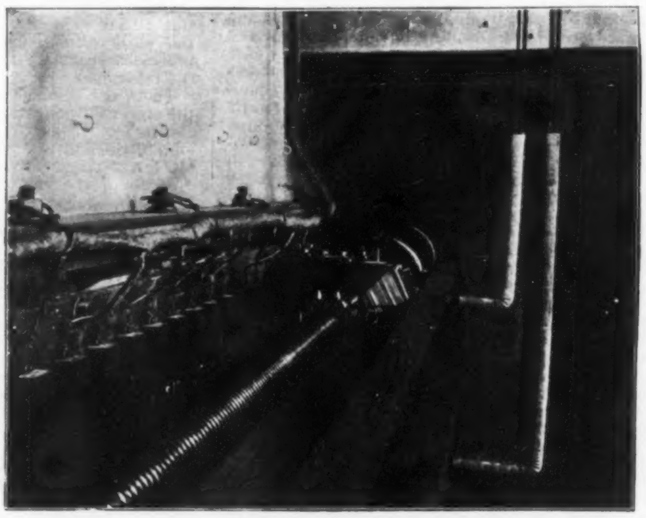

Fig. 2.—END CELL SWITCH.

An accumulator cell consists of three parts: the tanks, the plates and the electrolyte surrounding them. The retaining tanks for large batteries are usually of heavy ash, lined on the inside with pure sheet lead; while those used in small cells are of either hard rubber or glass. The Manchester positive * plate, made by the Electric Storage Battery Company, of Philadelphia, has a framework of lead alloy, containing a series of buttons. The framework gives conductivity and strength to the plate, holds the buttons in place and is continuous with the lug to which the bus-bar is connected.

The buttons, upon the surface of which is found the active material, are made of lead ribbons about 9 inches long and ½ inch wide, corrugated on one side and rolled up, making them about ¾ inch in diameter. These are put into holes in the alloy frame, which they just fit, and hydraulic pressure is brought to bear upon them, which, with the subsequent forming process, causes them to swell so that they fit firmly in their positions.

The special advantages of this button construction are that it is free from buckling caused by the unequal expansion of active material, and also that it exposes a very large surface to the action of the electrolyte. Its spiral formation permits the attainment of both these desirable qualities. Other batteries have differently formed plates, but all manufacturers endeavor to make a plate which will expose a large surface of active material to the electrolyte and which will be free from danger of scale and metal short-circuiting the cell internally, and at the same time be durable and free from buckling.

As nearly as may be, the negative plate is of pure lead, but in an allotropic state. Its construction is somewhat different than that of the positive plate, although a few years ago both plates were formed in a similar manner and like the present negative. The essential qualities of a good negative plate are that it shall have good conductivity and a framework strong enough to hold in place the active material which must compose a greater part of the plate. In the chloride plate a compound containing lead chloride is formed into tablets about ¾ inch square and ¼ inch thick. These squares are placed in a mold, and a grid of nearly pure lead is cast around under hydraulic pressure, leaving them about ⅓ inch apart. They are intended to be as close together as the mechanical construction of the plate will allow. After casting, the plates are subjected to an electro-chemical reduction process, which removes the chlorine from the tablets and leaves them in the form of spongy lead, chemically pure and very porous.

* The terms positive and negative apply to the terminals of a battery exactly the same as we apply them to the terminals of a dynamo.

A good positive plate must have ample surface over which the active material may spread, while it is essential that the negative be porous enough to allow a rapid diffusion of circulation of the acid as it comes in contact with the lead particles, not merely on the surface, but throughout the mass. On this quality depends to a great extent the maximum rate of charge and discharge. If a particle of lead, after being partially sulphated, is surrounded by a dilute solution of sulphuric acid, having a high resistance and low specific gravity, it is practically incapable of adding any energy to the circuit of which it is a part until a stronger (and hence lower resistance) solution of acid has come in contact with it. At any given rate of discharge, the attainment of this state of helplessness on the part of the particles composing the negative plates is the working limit.

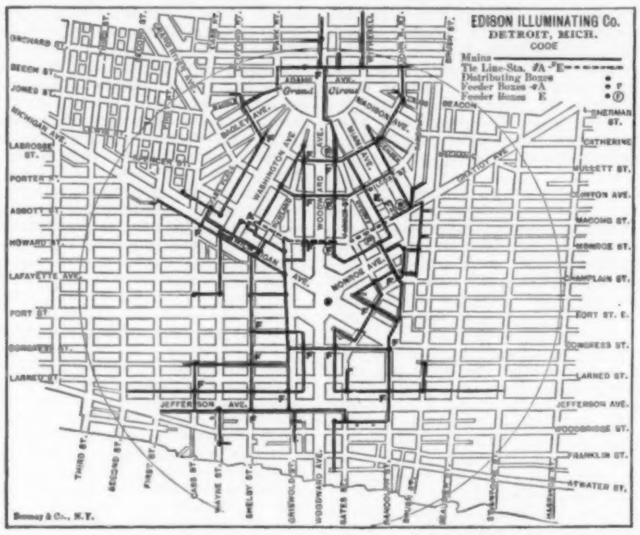

Fig. 3.—PLAN OF COMPANY'S SYSTEM.

A short rest, or a lower rate of discharge, will allow the cell to regain the normal voltage corresponding to the amount of active material left unacted upon in the plates. It will thus be seen that the freedom with which the electrolyte may diffuse in the plates decides the question of the maximum charge and discharge rates of the battery.

An ideal battery would be one which gave up the same number of ampere hours whether discharged at a high or at a low rate. In central station work, where the load is fluctuating, and especially where there is a very decided peak for a short time, say for one hour, it is the battery with sufficient capacity to carry that peak that is wanted; and yet in the accumulator of to-day the total capacity at the one-hour rate is only half what it is at the eight-hour rate, and only a few years ago the maximum was very little over the eight-hour rate.

The voltage, on open circuit between the positive and negative plates of a cell, ranges from 2 to 2.2 volts. This variation depends upon the type of cell and upon the state of charge. As soon as discharge begins the pressure drops, and it continues to drop until the limiting point is reached, which is about 1.7 volts. This lower limit coincides with the reduction of all the available active material. The reaching of this limit, as already noted, does not prove that there is no more active material left in the plates, but only that there is none in working contact with the electrolyte. Sometimes a series of cells may have an average voltage less than 1.7, which means that some cells are useless and are being charged by the current forced through them by the others in the series.

The electrolyte is dilute sulphuric acid, 28 per cent by bulk. Both acid and water must be chemically pure. The impurities most to be avoided are those which affect the chemical reactions in the plates, the metals being particularly objectionable. The acids other than sulphuric which are present in commer-

cial sulphuric acid—*i. e.*, nitric and hydrochloric acid—are likewise to be avoided. There is evaporation of water from the surface of the electrolyte, and there is a loss of fluid by spraying during the latter part of charge. These losses have to be made good by the addition of pure water and new electrolyte. A still for water distillation is a common annex to a large battery. The loss of acid is usually negligible.

Setting Up.—In setting up a battery, the positive plates of one cell are connected to a lead bus-bar, on the opposite sides of which are connected the negatives of the next cell.

Fig. 1 shows the arrangement of plates and bus-bar connections. At present the plates occupy only one-half of the available space in the tanks. The battery will be completed as the demand for service requires increased capacity.

Connection to System.—In connecting the battery to the system, three methods may be followed, according to the manner in which the battery is operated.

In railway work, and particularly in suburban lines when the potential of the system is extremely variable, the battery is connected in multiple with the system. It discharges when there is a drop in voltage caused by a heavy demand for current, and receives its charge when the voltage rises above the normal pressure of the system. At all other times it is allowed to float, neither charging nor discharging. A cable connection is usually made to a generator, so that an occasional charge may be given it if necessity demands. No other regulating apparatus is required. A battery connected in this manner is used simply to equalize the pressure on the system, and does not sustain any regular charge and discharge.

In street railway systems, where the battery is used not only to equalize the pressure, but to carry regular peaks, special apparatus for charging and discharging must be provided. The apparatus used for this purpose is called a "booster." A booster is simply a motor-driven generator in series with the battery circuit. When a charge is given the battery the booster raises the pressure at the terminals of the accumulator sufficiently to force through it the desired amount of charging current. On discharge it has a reverse action, and lowers the pressure over the battery until the desired discharging current is obtained. The booster commonly used in railway operation is a "differential booster," so called because it has a differential winding which permits the charge and discharge to be governed automatically.

In a lighting system, where the pressure must be kept much more constant than in railway work, the regulation is controlled by a series of end-cells connected to end-cell switches, together with a booster. The booster may be used for either charging or discharging, but has no automatic controlling arrange-

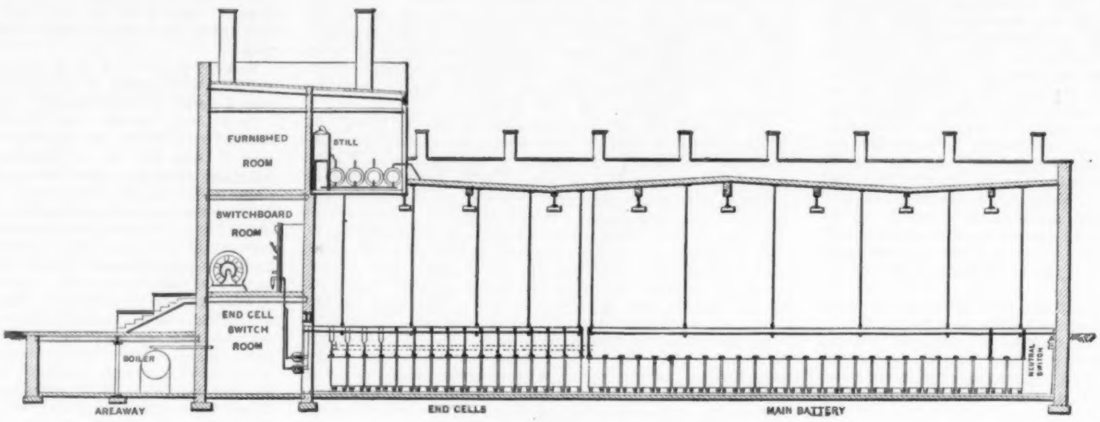

FIG. 4.—SECTION OF STATION.

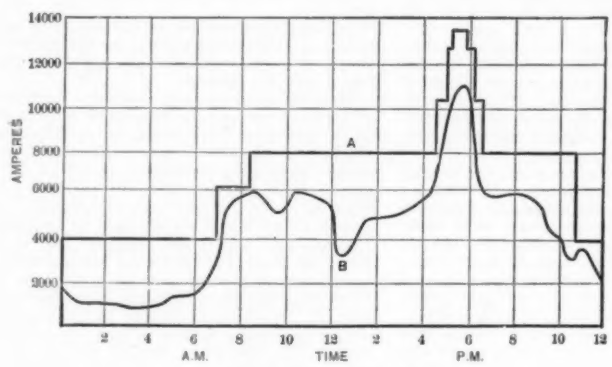

FIG. 5.—LOAD CURVE.

Thursday, January 25, 1900. Storage battery not installed.

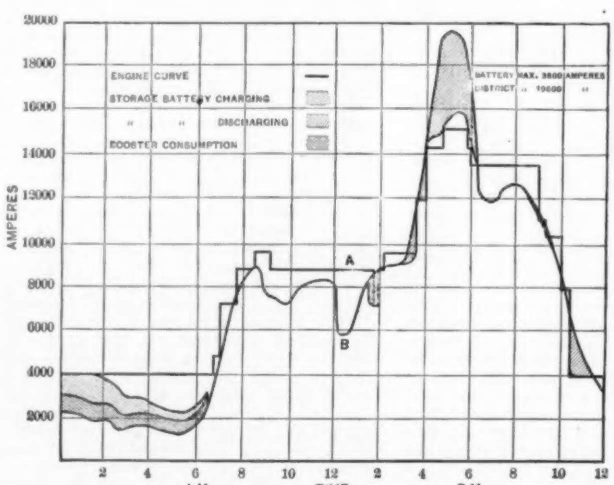

FIG. 6.—LOAD CURVE.

Tuesday, December 18, 1900. Storage battery installed.

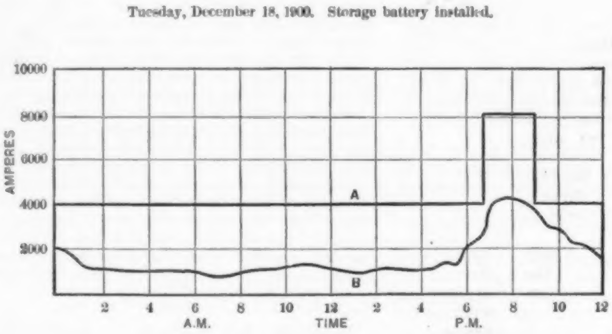

FIG. 7.

Sunday, September 23, 1900. Storage battery not installed.

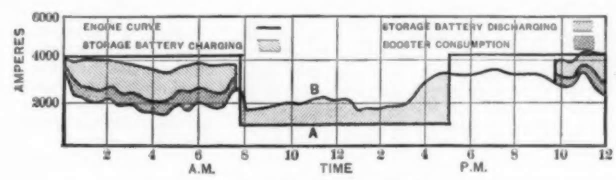

FIG. 8.—LOAD CURVE.

Sunday, November 25, 1900. Storage battery installed.

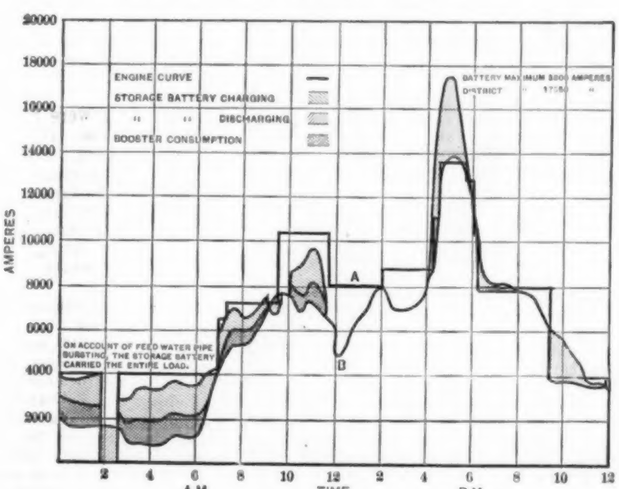

FIG. 9.—LOAD CURVE.

Wednesday, November 21, 1900. Storage battery installed.

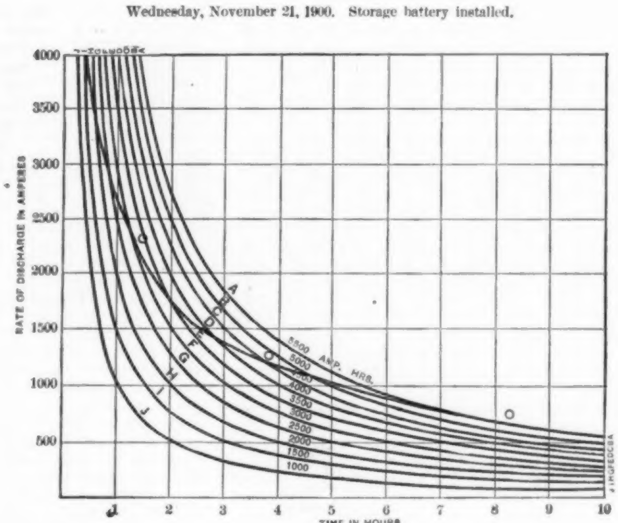

FIG. 10.—BATTERY CURVES.

Capacity curve shows capacity of battery at different rates of discharge. Discharge curves show various discharges in ampere hours and their relation to the capacity curve.

ment. It is customary to use the booster only on charge. The discharge is controlled by the end-cell switches.

The so-called "end-cells" are merely a certain number of the terminal cells of battery, so arranged that any number of them may be successively connected in series with the main battery as the load increases and cut out again as the load drops off.

The number of end-cells, as well as the number in the main battery, depends upon the voltage at which the system is operated. The maximum voltage of the main battery must equal the normal voltage of the system. There must be a sufficient number of end-cells to insure proper regulation under all conditions of charge, and also to provide for the distribution drop of the system. For instance, in a 125-volt system this would mean fifty cells in the main battery and about thirty additional end-cells to give a bus-bar voltage of 136 at end of discharge. From the cell bus-bars between the end-cells copper leads are run to the end-cell switches, terminating in a series of studs arranged in succession. Parallel to these studs is a copper slide, from which connection is made to the switchboard. A laminated copper brush, making sliding contact with the slide, is moved successively over the studs by means of a screw propelled either by hand or by a motor.

Fig. 2 shows one of the end-cell switches, showing the arrangement of the copper slide and studs.

The operation of the battery is very simple. In the Edison system, for instance, the pressure across the mains is about 120 volts. In order to balance the battery against this pressure it will be necessary to have about 60 cells in series, counting two volts per cell. In this condition it acts as a regulator, or floats; for if there is a rise of pressure on the mains, due to a sudden cessation in the demand for current, the battery will absorb the surplus energy by suffering a slight charge; while, on the other hand, should the pressure suddenly fall, the battery discharges enough to keep the voltage almost constant in the system.

In street railway work, where the load is much more fluctuating than in lighting, this characteristic of the battery is of great consequence.

As the cells discharge, additional cells have to be added, in series with those already in, in order to keep the pressure constantly 120 volts at the service ends of the mains. This is done by moving the sliding contact brush further along the end-cell switch. As the load drops off, these cells, previously cut in, have to be cut out again. This is done by moving the brush in the opposite direction. The end-cell switches are operated from the switchboard, so that the operator has complete control of the battery from his position at the board.

Availability.—In order that the effect of the Edison battery may be easily understood, I wish to say a word concerning the general plan of the Edison Illuminating Company's underground distribution system. This will be necessary because the battery plant is now a part of that system, and its value can better be appreciated when the conditions of the field previous to the installation of the battery are understood.

The main station (Station "A," corner of State Street and Washington Avenue) has been, and is at present, the generating plant for nearly all the current used in the underground system.

Fig. 3 is a diagram showing the relative positions of this station and the centers of distribution of the underground system within the half-mile circle; also the location of the battery station, Station "E."

Last spring the Edison Illuminating Company was facing the proposition of determining the most economical way to increase the output of the generating station. It was estimated that the holiday season load would run about 4,000 or 5,000 amperes, or 500 to 600 kilowatts higher than the year before; and in the previous year the station was loaded to its full capacity. Owing to the already crowded condition of Station A, the cost of installing generating machinery sufficient to supply the demand for the coming year, with some facilities for taking care of the probable increase of load of the following season, would, it was figured, be greater than the cost of an accumulator plant.

Furthermore, it was not only undesirable, but next to impossible, to increase sufficiently the output of Station A.

A converter station, taking power from our alternating system, and situated where the battery, Station E, now is, would have been a possible expedient had it not been for the fact that the peaks, on both the Edison and the alternating stations, take place about the same time. The additional equipment necessary to insure service equal to that given by the battery would have cost more than the battery. The peak, which comes only in the winter months, lasts, all told, not more than 125 hours per year; and to install generating machinery to carry that load for that length of time, and to lie practically idle for the remainder of the year, would mean an expenditure of money difficult to realize encouraging dividends on. With a storage battery plant it is different; it takes the high peak in the winter months and furnishes the system with sufficient reserve at all times, while at the same time it allows two-thirds of its capacity to be used at will every day in the year. Whatever the advantages afforded by the battery, they are felt every day. Fewer boilers have to be kept fired up and fewer engines ready to run, and the generating machinery can be worked at the point of greatest economy.

Location.—The decision to install a battery led to the investigation of possible sites. A theoretical location could have been easily determined by taking into account the existing conditions and the possible extension of the system had not other conditions introduced very important limiting factors. These factors included the available sites, their comparative cost and the comparative cost of copper necessary to make the best connection to the system, besides the fire risk to which the location of each would subject the battery plant.

Construction of Building.—The lot selected gave no excess of space. The section elevation of the battery station shows this (see Fig. 4).

To get the battery in place without crowding, and with convenient arrangement of copper, required considerable study. The final copper plan was drawn by the battery company after the dimensions of the room were fixed by us, and the copper and switches were got out according to this approved plan while the building was in progress. Work was begun on the foundation May 1, 1900, and the building was finished in August.

The wall above the opening for the end-cell switches is of brick, clear through to the roof, thus separating the battery room from the rooms in front. There are good reasons for having it so arranged, the principal one being that it protects the cells from fire originating in the dwelling rooms. Fire is not likely to originate elsewhere. The switchboard and booster room is directly above the end-cell switch room. All the operating is done from this room.

To go back to the construction of the building. It is absolutely necessary that there be a good foundation, for there are 160 tanks, weighing about 2 tons apiece, in a room 30 x 85 feet. These must be kept in perfect alignment, and any sinking or failing in the foundation would cause serious trouble. The natural foundation was found to be of clay. A good system of drainage was put in the ground, so that the tile came under the walks between the tanks, and then a covering of concrete 16 inches thick was spread on, coarse at the bottom and finer at the top. This used up the material of the building found on the lot. Upon this were placed extra heavy paving bricks. It took eight barrels of pitch, between the bricks, to complete the foundation, which, when it was done and dry, was perfectly level and also a good insulator. One fails to detect the slightest sign of a current when standing on the floor and feeling at the same time any of the live conductors. (Those who are accustomed to getting a poke every time they lay a hand on a wire around a station will appreciate the convenience of having a non-conducting floor.)

The side walls are of red pressed and partially vitrified brick to a height of about 9 feet above the floor, continuing the rest of the way of ordinary building brick. This pressed brick is acid-proof. The front is of gray pressed brick, and so designed as to give the building the appearance of a dwelling house rather than that of an electric lighting station.

Installing the Battery.—The setting of the tanks was an operation requiring great care. On account of their weight, they must be well supported. Insulation, too, is a matter of great importance. Each tank is supported on eight petticoated insulators, which rest on vitrified tile 7 inches wide and ¾ inch thick, set to a templet and on sulphur. With the tile set and the porcelain insulators fastened to the bottoms of the tanks by being stuck into their places with hot pitch, the operation of tank setting became both simple and rapid. As soon as a few tanks were put in place, the glass supporting plates were put in, and the battery plates supported on these. In this way a large force of men was kept at work. Different gangs were setting tile and tanks, and cleaning up plates and putting them in place in the tanks at the same time. As soon as it could be done, the work of burning the plates to the lead bus-bar was commenced.

Burning is necessary instead of the more convenient soldering, because solder would be promptly attacked by the acid spray.

Perhaps the most interesting of all the work was filling the tanks with the acid. At the rear of the building was placed a tank similar to one of those used for the battery, and about 8 feet above them. Ten rubber tubes (garden hose) were constantly siphoning the acid from the tank to the battery tanks. A gang of men was emptying carboys into the upper tank as fast as they could be handled. A carboy would be tipped upside down over the tank, the box surrounding it supporting it in such a way that its neck extended into the tank about 5 inches. The acid in the tanks could therefore never get above the level of the mouth of the carboy as it was thus inverted. As soon as one was placed on the tank and started to empty, it was shoved along to make room for another, and was empty by the time two others had been put on behind it. The process was very rapid, and over 2,000 carboys were emptied in about a day and a half. Everything had to be so far completed by the time the acid was in that the first charge could begin immediately afterward, for it injures the plates to allow them to stand in the electrolyte for any length of time in an uncharged condition. The injury is in the formation of an irreducible sulphate.

The first charge was begun immediately and continued for thirty hours, the rate being comparatively low—500 amperes to start with and increased later to 700 amperes. The cells were overcharged on the first occasion and on the next few charges, the object being to complete the formation of the active material, which is nearly, but not quite, completed when the plates leave the factory.

Operation.—The subject of operation can be best understood by an inspection of the following curves:

Fig. 5 shows a characteristic load curve previous to the installation of the battery.

Line *A*, called the engine curve, represents the normal rating of the units running. Line *B*, called the commercial load curve, represents the amperes supplied to the system.

It will be noticed that the load factor of the engines' run—that is, the ratio of the ordinates of curves *B* to *A*—is comparatively low. It was necessary to run the engines at this low load factor in order to secure reliable service under all conditions of operation.

Fig. 6 illustrates a characteristic load curve after the battery was installed. The cross-hatched areas represent the operation of the battery. It will be noticed that the load factor has been greatly increased. This is due to the fact that the battery was on the system and supplied a reserve, making it unnecessary to run generating machinery below the normal rating, as was done before the battery was installed.

Figs. 7 and 8 are characteristic Sunday load curves, before and after the battery was installed respectively. Compare again the load factors in the two cases.

Fig. 9 shows the operation of the battery in emergency cases. On account of a feed-water pipe bursting at the generating station, the plant was shut down for about three-quarters of an hour, while the battery carried the entire district load, giving the engineers sufficient time to get another boiler unit in commission.

Fig. 10. Curve *O O O* is the battery capacity curve, made up from data furnished by the Electric Storage Battery Company. The discharge rates are plotted as ordinates; the time and hours as abscissas, the capacity being 2,750 ampere hours at the one-hour discharge rate, 3,750 at the two and one-half, 4,350 at the three and 5,440 ampere hours at the eight-hour rate.

Curves *A A A*, *B B B*, etc., are curves showing the various discharges in ampere hours, plotted in a similar manner to the capacity curve.

It is well known that the available capacity of a battery increases as the rate of discharge decreases, and it was for the purpose of showing the relation existing between them that the capacity curve was superposed on the discharge curves.

Suppose at any particular time it is known that, say, 2,500 ampere hours have been taken from the battery at various rates of discharge, and it is desired to know how long a certain discharge rate, say 2,000 amperes, can be carried. Follow up the 2,500-ampere discharge curve until it intersects the 2,000-ampere rate line. The distance between this point of intersection and the point where the 2,000-ampere rate line cuts the capacity curve represents the length of time that 2,000 amperes can be carried, which is about twenty minutes. With the battery in the same condition, 1,500 amperes could be carried for about forty-five minutes, as shown by the distance between the points of intersection of the 1,500-ampere rate line with the 2,500-ampere discharge curve and the capacity curve.

In a similar manner, it can easily be calculated how long any rate can be carried by the battery, or whether it can be carried at all, if the ampere hours previously taken out are known.

It is not customary to work the battery near enough to its limit to make it necessary to consult the curves. It is, however, very valuable in emergency cases to know how long a certain rate can be carried. The curves have been repeatedly found to be very reliable, and to know just how long the battery can be depended upon to carry a given load, if necessity demands, is a source of no small satisfaction to the operator.

Economy.—The real economy of an accumulator plant is hard to determine, constituting as it does only a small part of a large system, each department of which adds to or detracts from the economic operation of the whole, according to the degree of efficiency with which each branch is run. It would be unfair to expect the number of pounds of coal burned per kilowatt-hour output to be greatly decreased on account of having the battery in operation when it is remembered that only about 8 per cent of the output is dealt with by the battery. It has been impossible to get accurate data on this point. There has been a falling off in the amount of coal burned for a given output since the battery was installed, but I am not prepared to say that the saving in coal bills, calculated along that line, is more than enough to pay the operating expenses of the battery station.

I do hold, however, that the cost of operating and maintaining an accumulator plant (the one under consideration in particular) is no greater than that of a complete generating plant of the same capacity, and in the above-mentioned case the cost of installation of such a plant would have been in excess of the first cost of the battery. In such a steam plant we would not have expected any greater reduction in the cost of coal per kilowatt-hour than we have already experienced while using the battery. There are other reasons, however, for believing that the installation of the battery plant was a wise move. Situated as it is, it makes it possible to cover districts which could not be reached directly from Station A. Not only that, but the whole system feels the effect of the better regulation afforded by the battery. It acts as a reservoir, ready at all times to give energy to the system, and forestalling any drop in pressure which could be caused by the failure of any single unit at the generating station. It is customary to keep always enough reserve energy in the battery to carry for about an hour the load dropped by such an accident, giving the engineers plenty of time to get another set of generators or boiler plant in commission. This reserve amounts to about one-third of the capacity of the battery. We are at liberty, then, to use the other two-thirds in whatever way good operation demands.

So far the battery has given the best of satisfaction. During the summer months we expect to use it to as great an advantage as during the past winter. Thunder-storm peaks can be taken care of without the necessity of keeping boilers in readiness for such an emergency, and the load factor of the engines run can be raised to the most economical point of operation, reducing by no small amount the number of pounds of coal burned per given output. As a means by which the output of the system could be increased the battery was the cheapest and best; and as for supplying reserve, ready at a moment's notice, it has no equal. Its many other virtues only strengthen an ever-growing respect for it.

New Electric Railroad in Russia.—Consul-General Guenther sends the following, dated Frankfort, April 30, 1901:

The first electric suburban railroad in Russia was opened for traffic this year. It connects the manufacturing city of Lodz, in Russian Poland, with the neighboring towns of Zgierz and Pabianice, and is 13½ miles in length. The Thomson-Houston motors used were furnished by the Russian Electricity Union. The road is owned by a company of Polish merchants and manufacturers, and was built at a cost of $560,000. The charter provides that the Government shall receive a share of the profits, and shall have the right to purchase after twenty years; and that the road and all equipment shall become the property of the Government at the expiration of twenty-eight years.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Railways in China.—The Revue du Commerce Extérieur, Paris, June 1, 1901, gives the follwing list of foreign railway concessions in China:

LINES AT PRESENT EXPLOITED.

(1) Line from Shanghai to Wusung, constructed in 1896, destroyed soon after, and re-established in 1898; length, 18 kilometers (11.2 miles).

(2) Line to Pao-Ting from Tientsin, 60 kilometers (37.3 miles) north of the Great Wall by Shanhaikwan, with junction for Pekin; length from Shanhaikwan to Tientsin, 280 kilometers (174 miles); from Tientsin to Pekin, 135 kilometers (83.8 miles); north from Pekin, 65 kilometers (40.4 miles); total, 480 kilometers (298.2 miles). This line was constructed by the order of Li Hung Chang after 1876.

LINES CONCEDED SINCE 1897 (IN CONSTRUCTION OR PROJECTED).

Russia.—Line projected via Tsitsikhar, Kirin, Vladivostock, with branch line to Port Arthur and Niuchwang; length, from the Transbaïkal region to Vladivostock, 1,425 kilometers (885.4 miles); branch line to Port Arthur, 800 kilometers (497 miles). These lines are entirely in Russian hands. They have an immense strategic importance; they form the shortest route connecting Europe and the Far East. Commenced in 1897, they will perhaps be completed in 1904-1905. The Russian network will be joined with the Chinese network by the line from Shanhaikwan to Niuchwang, with branch line to Sin-Minting, near Moukden.

Germany.—Triangular line from Kyao-chau to Chinan to Yen-Shun and from Yen-Shun to Kyao-chau; length, 1,000 kilometers (621.4 miles). This is the shortest route leading from the navigable part of the Yellow River to the sea. The loan was subscribed at Berlin June, 1899.

France-Belgium.—Line from Pekin to Hankau. This is the first railway decreed by imperial edict in China. The loan was placed in circulation in Paris and Brussels in April, 1899. The works on the north have been commenced by English engineers. The road is finished as far as Pao-Ting-fu, 80 kilometers (49.7 miles) distant from Pekin, and now running. The construction has stopped 100 kilometers (62.1 miles) from Pao-Ting-fu and the surveys are finished as far as Chun-Thé, or to 200 kilometers (124.2 miles) farther to the south. On the side of the Yangtze the works are completed to Sin-Yang, 200 kilometers (124.2 miles) from Hankau. This long line will be joined by a first branch at Taï-Yuan-fu and by a second at Tsinan-fu.

England-Germany.—Line from Tientsin to Chinkiang; length, 1,000 kilometers (621.4 miles), with branch line to Tsinan. The northern part will be confided to German engineers; the southern part to English engineers.

England.—The Pekin syndicate intends to build the line from Taï-Yuan to Fu-Shun-fu; length, 450 kilometers (279.6 miles). The British-Chinese corporation has obtained the concession for two lines starting from Shanghai, of which one will go toward the northwest to Su-chu, Chinkiang, and Nankin, and the other to the southwest—to Hang-chu and Ning-Po.

Southern China.—Line from Canton to Hankau, with branch line to Hongkong; length, 1,200 kilometers (745.6 miles). The road will be built by a Belgian syndicate.

Railways of the French Tonkin.—(1) Line from Lao-Kaï to Yunnan; (2) line from Lang-Sou to Long-Shun; (3) line from Nan-Ning to Pakhoi.

American Wheat for Italian Macaroni.—After efforts covering a period of over two years, I have succeeded in demonstrating the fact that the very finest quality of macaroni can be made of American wheat. This has been declared an impossibility by those engaged in its manufacture here, and there are hundreds of establishments in this district. Up to the present time, Russian wheat and wheat from the Orient have been used, together with Italian wheat, for the production of this article of food, the American wheat being considered too soft. Through the co-operation of one of the largest establishments in this district, it has been found that this conclusion was based upon the proverbial conservatism of the people. When it is remembered that macaroni consists of wheat to the extent of 60 per cent, it will be readily seen that here is an opening for American wheat of no inconsiderable importance. It should be understood that while there is a tax on American wheat, there is also a tax on all foreign wheat—7.50 francs ($1.44) for 100 kilogrammes (220.46 pounds). It should also be borne in mind that international freights covering transportation of grain from Russia, the Orient, and the United States are practically the same.

I inclose extracts from a letter from one of the largest manufacturers in Italy, and send also a sample of crude American wheat, with a sample of the wheat ground, and a sample of macaroni made from the same.* It has been suggested to me that if the United States government would admit free of duty, or at least at a lower tax than the present tariff, macaroni made from American wheat, a market for our wheat would be opened in competition with that of Russia and the East. The present tariff on 1,000 pounds of macaroni is $15, or 1½ cents per pound; under the plan proposed, 60 per cent of the said 1,000 pounds would enter free, leaving 40 per cent to be taxed at the present rate of 1½ cents per pound, making on the 1,000 pounds a tax of $6, instead of $15. It should be remembered in this connection that the Italian manufacturer of macaroni, under the scheme proposed, would have to pay freight from the United States to Italy, and also pay freight on the same wheat manufactured into macaroni and transported to the United States.—Joseph E. Hayden, Consul at Castellamere di Stabia.

Gas and Oil Discoveries Near Ottawa.—For several years there has been discussion of work done in the vicinity of Ottawa in the discovery of oil and gas. As the locality is only 55 miles from the New York State line, I give below a description of the investigations that are going on, with a brief history of the borings, etc., that have taken place in this neighborhood.

Some thirteen years ago Ottawa was startled somewhat by the supposed discovery of petroleum at Ramsay's Corner, 10 miles from this city. One Mr. John Cunningham brought a bottle of tarry matter with a strong odor of petroleum, which he claimed to have found on his father's farm. A sample was sent to an assay office in New York and the report came that it was petroleum, a fine specimen of condensed grade.

A company was formed, which bored to the depth of 1,005 feet. Neither gas nor oil was found; sulphurous water was struck, however, at 320 feet, and salt water at 550 feet. This disheartened for the time seekers for oil and gas about Ottawa. Two years ago Senator Poirier, of New Brunswick, undertook to make a thorough study of the geological and stratigraphical conditions of the Ottawa Valley, aided by one of the leading geologists in America.

The counties of Carleton, Russell and Prescott were thoroughly investigated. No less than one hundred and fifty bore holes down to the rock (but not into the bed-rock), at depths varying from 25 to 204 feet, were made by an artesian-well bore through the overlying clay (mostly blue clay), and a reliable map was drawn. The bore hole of 1889, in the suburbs of Ottawa, was examined, and it was found that it had been sunk where the Trenton limestone crops out uncovered at the surface, a condition fatal to the finding of petroleum oil and natural gas.

At Cunningham's farm the Trenton limestone is covered by the Utica shale and the Hudson River shale, and by 204 feet of overlying blue clay, remarkably soft. The elevation of the surface is about 260 feet above sea level.

Senator Poirier started boring this last winter, with a diamond drill owned by the Ontario government. No boring had ever been made through the belt of the Hudson and Utica formations around Ottawa, and from surface exposures, the Geological Bureau of Canada had come to the conclusion that the maximum thickness of the combined Hudson River and Utica strata would not exceed 300 feet. The Ontario diamond drill had a capacity of 469 feet. At that depth the drill, on close examination of the fossils found in the cove, had not traversed the Hudson formation. At about 445 feet from the surface a column of water and gas about 30 feet high spurted out, but lasted only twenty-four hours. The water, I am informed, showed positive evidence of oil, being covered with an oily cream.

Deducting from 469 feet the 204 feet of overlying clay, the drill at Cunningham's farm had only penetrated the rock 265 feet. It was thought advisable to drill from a point where the rock outcropped at the surface. Such a point was shown to exist some 3 miles away. At this spot the stratum was found to be horizontal and altogether undisturbed.

At 450 feet a strong pressure of gas was met, 200 pounds to the square inch, according to the official report. The drill could only reach a few feet lower, and the boring had to be abandoned. At that depth the drill had, upon examination of the fossils, barely reached the Utica shale.

The drill hole, which is 1¼ inches in diameter, has been left unplugged and has continued ever since to give out gas—rock gas without doubt. The water that comes out is coated with greasy matter, with spots resembling oil.

Encouraged by these results, Senator Poirier and his associates secured a pumping drill of 2,000 feet capacity and started boring a new hole on Cunningham's farm, some 30 feet from the first one. On the 31st of May last the drill had reached 540 feet from the surface; that is, 336 feet in the bed rock. The driller had met with no phenomenon, except a stronger jet of water and gas at about 490 feet, which, however, did not last. There are appearances of a tarry substance on the water.

Oil is expected to be struck at about 900 feet from the surface; that is, 700 feet below the rock, at the contact of the Trenton limestone with the Utica shale. In Ohio and Indiana it has been found at that horizon. What is required now is a thorough equipment of drills to properly test this basin.—Charles T. Turner, Consul-General at Ottawa.

Engines in Egypt.—Consul Hughes sends the following from Coburg, May 15, 1901:

It is stated that a public competition has been opened in Upper Egypt for the delivery of four vertical compound high-pressure engines to work centrifugal pumps for irrigation purposes. The contract will also include the delivery of six steam boilers, to be connected with the engines. All must be delivered at Esta, on the Upper Egyptian Railway. The plans may be examined at the bureau of the inspector-general of the irrigating system for Upper Egypt, at Cairo, and all offers must be submitted to him by June 25, 1901.

Financial Conditions in Japan.—Consul-General Bellows sends from Yokohama, May 3, 1901, a clipping from the editorial columns of the Japan Daily Mail, as follows:

"Japanese public opinion is gradually turning toward a foreign loan. Even in quarters where this expedient has not hitherto been approved, it is now very strongly recommended. Unhappily, the time is very ill suited for an appeal to the money markets of Europe or America, not only because the floating capital of Europe has of late been subjected to a heavy drain, but also because Japan's credit is not good at present. Whether it be her misfortune or her fault, Japan never comes upon the world's financial stage in any character save that of an impecunious state. It is to her monetary embarrassment that the attention of the foreign public is constantly drawn; not to her resources or her opportunities. Her unique difficulty at present is that her large surplus of revenue does not suffice to meet her extraordinary outlays on account of productive enterprises, and that she can not obtain loans from her own people, who find that all their available money may be employed much more profitably than in lending it to the Government. There is no question of real impecuniosity. The whole problem is to find the means of utilizing wealth-earning opportunities. No western country would hesitate to appeal to foreign capital under such circumstances, and if Japan were a western state she, too, would not hesitate."

Exportation of Siberian Butter.—Russian papers state that the Secretary of the Treasury of Russia has entered into a contract with a commercial house at Riga to establish a direct line of steamers between that city and London, for the purpose of exporting those agricultural products of Russia which are easily spoiled en route.

The Riga firm has had refrigerator steamers built, and weekly trips will be inaugurated in the near future.

Fast freight trains will leave the station at Ob, on the Siberian Railroad, for the shipment of butter. Each train will consist of twenty-five special cars with refrigerating equipments, containing about 8 tons of butter per car. The route is by way of Kainsk, Tatarskaja, Omsk, Petropaulowsk, Kurgan, Chelyabinsk, Batraki, Rusajewka, Moscow, and Bologoge to Riga, where the train will arrive every third Thursday. As soon as the line between Moscow and Kreuzburg is completed, this route will be taken, the distance being shorter.

For these special trains, the railroads have had 138 refrigerator cars built. Ice will be supplied at the various stations of the Siberian and other railroads.

After arriving at Riga, the butter will be inspected, and, if necessary, repacked for steamer transportation. This fast freight train will also transport other articles, provided they do not interfere with the shipments of butter. In this manner, 35,000 barrels of butter will be exported during the summer, each barrel containing from 130 to 150 pounds.—Richard Guenther, Consul-General at Frankfort.

French-Canadian Steamship Line.—Under date of May 29, 1901, Consul-General Turner, of Ottawa, informs the Department that the Canadian Government has signed a contract with the Franco-Canadian Steamship Company, for the establishment by the latter of a steamship service between Dominion and French ports. The contract is to run for a year from the 1st of July, 1901. In summer, fortnightly trips will be made from Montreal and Quebec, and in winter monthly trips from St. John and Halifax. The contract is based upon a tonnage rate per voyage; and on an estimate of eighteen trips, the company would earn $50,000 the first year.

The Consul-General adds that as there is a subsidy of $100,000 available, there is some talk of the company increasing the number of steamers, so as to give a weekly service during the summer.

Remodeling Russian Harbors.—Under date of May 1, 1901, Consul-General Guenther, of Frankfort, reports that the Russian Government has concluded to remodel the harbor works at St. Petersburg and Cronstadt, to conform with modern requirements. The Consul-General adds that it is also contemplated to separate the naval from the commercial harbors. Cronstadt will become a naval port only, and will be closed to merchant vessels, while St. Petersburg will be the commercial harbor. On the Black Sea, the commercial harbor at Sebastopol will be removed to Feodosia.

German Technical Bureau.—Deputy Consul-General Hanauer writes from Frankfort, May 18, 1901:

Steps are being taken for the creation of a federal bureau of technics in Germany. On the executive committee having charge of this plan are members of the leading chemical works, the German Association for Protecting the Trades, the Technical Association of Germany, the Association of German Engineers, the Union of German Patent Lawyers, the Central Bureau for Scientific Investigation, the Institute for Fermentation, the German Tobacco Association, electrical companies, and others.

Demand for Lamps in British India.—Consul-General Guenther writes from Frankfort, May 7, 1901, as follows:

According to Informations et renseignements de l'Office national du commerce extérieur, there is a strong demand for cheap, simply constructed lamps in British India. The article adds that the old means of lighting are being rapidly superseded by modern methods, and that manufacturers of cheap lamps may find it to their interest to correspond with importing firms at Calcutta and Bombay.

An American Bank in Germany.—Deputy Consul-General Hanauer, of Frankfort, under date of May 17, 1901, says:

The establishment of an American bank in Berlin and London is contemplated. It is believed that this will open the way for American industrial undertakings and exports in the countries of the Old World.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

* Transmitted to the Department of Agriculture with copy of this report.

TRADE NOTES AND RECEIPTS.

Production of Fixative.—A reliable recipe for the production of a fixative is the following:

Shellac	40 grammes.
Sandarac	20 grammes.
Spirit of wine	940 grammes.

—Farben Zeitung.

New Explosive.—A new blasting agent, protected by German patent No. 118,356, consists of a mixture of barium peroxide and calcium carbide. The explosion is caused by admixture of a dilute acid, which generates at the same time gases of acetylene and of hydrogen peroxide. The cartridge consists of two compartments separated by very thin sheet zinc. One compartment receives the salt mixture, the other the diluted acid, which quickly destroys the partition, thereby coming in contact with the acid mixture. At that moment a heavy explosion occurs.

Dust Absorbent.—This dust-absorbing agent has for its object to take up the dust in sweeping floors, etc., and to prevent its development. The production is as follows: Mix in an intimate manner 12 parts (by weight) of mineral sperm oil with 88 parts (by weight) of Roman or Portland cement, adding a few drops of mirbane oil. Upon stirring a uniform paste forms at first, which then passes into a greasy, sandy mass. This mass is sprinkled upon the surface to be swept and cleaned of dust, next going over it with a broom or similar object in the customary manner, at which operation the dust will mix with the mass. The preparation can be used repeatedly.—Neueste Erfindungen und Erfahrungen.

Preparation of Coffee Essence.—Finely grind 600 grammes of freshly roasted coffee in a coffee grinder and saturate with the requisite quantity of a mixture of 120 c. cm. of spirit of wine (90 per cent) and 360 c. cm. of distilled water. The moistened coffee is placed in a percolator and percolated, after standing for 24 hours, with the rest of the spirit of wine and water mixture, and then with distilled water until 480 c. cm. of percolate is obtained. Set the percolate aside, exhaust the coffee in the percolator with hot water, evaporate the second percolate to the consistency of extract and mix it with that first obtained, whereupon, if necessary, this mixture is allowed to deposit and filtered.—Pharmaceutische Zeitung.

Sterilization of Sponges.—A very simple process for the sterilization of sponges, which does not change the physical properties of the sponges, is given by Elsberg in the Chemiker Zeitung Repertorium. Allow the sponges to lie for 24 hours in an 8 per cent hydrochloric acid solution, to eliminate lime and coarse impurities, wash in clean water and place the sponges in a solution of caustic potash 10 grammes, tannin 10 grammes and water 1 liter. After they have been saturated for 5 to 20 minutes with this liquid, they are washed out with sterilized water or a solution of carbolic acid or sublimate, until they have entirely lost the brown coloring acquired by the treatment with tannin. The sponges thus sterilized are kept in a 2 per cent or 15 per cent carbolic solution.

Preparation of Artificial Mineral Salts.—

KISSINGEN SALT.

Potassium chlorate	17
Sodium chlorate	367
Magnesium sulphate (dry)	59
Sodium bicarbonate	107

For the preparation of Kissingen water, dissolve 1.5 grammes in 180 grammes of water.

VICHY SALT.

Sodium bicarbonate	846
Potassium carbonate	38.5
Magnesium sulphate (dry)	38.5
Sodium chlorate	77

For making Vichy water dissolve 1 part in 200 parts of water.—Neueste Erfindungen und Erfahrungen.

Water and Acid Resisting Paint.—According to this process caoutchouc is melted with colophony at a low temperature, after the caoutchouc had been dried in a drying closet (stove) at 70 to 80 deg. C. until no more considerable increase in weight is perceptible, while the colophony has completely lost its moisture by repeated melting. The raw products thus prepared will readily melt upon slight heating. To the melted colophony and caoutchouc add in a hot liquid state zinc white or any other organic pigment, while the whole is thinned with a colophony varnish of special composition. This varnish consists of 50 parts of perfectly anhydrous colophony, 40 parts of absolute alcohol and 40 parts of benzine. The whole sirupy mass is worked through in a paint mill to obtain a uniform product, at which operation more or less colophony varnish is added according to the desired consistency.—Lack und Farben Industrie.

Blackening Hardened Steel Tools.—Oil or wax may be employed; with both methods the tool loses more or less of its hardness and the blacking process therefore is suited only for tools which are used for working wood or at least need not be very hard, at any rate not for tools which are employed for working steel or cast iron. The handsomest glossy black color is obtained by first polishing the tool neatly again after it has been hardened in water, next causing it to assume on a grate or a hot plate the necessary tempering color, yellow, violet, blue, etc., then dipping it in molten, not too hot, yellow wax and burning off the adhering wax, after withdrawal, at a fire, without, however, further heating the tool. Finally dip the tool again into the wax and repeat the burning off at the flame until the shade is a nice lustrous black, whereupon the tool may be cooled off in water. The wax is supposed to impart more toughness to the tool. It is expedient for all tools to have a trough with fat ready, which has been heated to the necessary tempering degree—according to a thermometer—and the tools after the hardening in water are suspended in the fat until they have acquired the temperature of the fat bath. When the parts are taken out and slowly allowed to cool, they will be a nice but not lustrous black.—Zeitschrift fuer Werkzeugmaschinen und Werkzeuge.

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